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The Geographical Journal.

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The
Geographical Journal.

No. 3. SEPTEMBER, 1910. Vol. XXXVII.

THE SOUTH-WEST INDIAN OCEAN.*

(Being an Account of Aldabra and Certain Neighbouring Islands, which were not explored by Prof. J. Stanley Gardiner in H.M.S. "Sealark.")

By J. C. F. FRYER.

The expedition of which the following paper gives some account was made to investigate certain small islands in the Southern Indian ocean, which from their structural affinities appear to form a distinct series. These islands consist of Aldabra, Assumption, Cosmoledo, Astove, Farquhar, Providence, and St. Pierre, all of which lie to the north of Madagascar between latitudes 9° S. and 10° 6′ 45″ S., and between longitudes 46° 14′ 41″ E. and 51° 10′ 3″ E. To the north-east of this area is the Seychelles archipelago; to the west, Africa; to the south-west, the Comoros; while to the east lies the Saye de Malha bank and the almost landless expanse of the South Indian ocean. There is evidence, though not complete, to show that all the islands of the series arise from a deep bank some 1000 fathoms from the surface of the sea. As the need for the exploration of these small and obscure islands may not be apparent, I will first refer to the two most important expeditions which have investigated the Indian ocean in recent times: these are Prof. J. Stanley Gardiner's expeditions to the Maldive and Laccadive archipelagos in 1899–1900, and that in H.M.S. *Sealark* in 1905, accounts of which have appeared in this *Journal* in the years 1902 † and 1906 ‡ respectively. Among the various problems, which

* Read at the Royal Geographical Society, April 25, 1910. Map, p. 380.

† *Geogr. Journ.*, 1902, p. 1.

‡ *Ibid.*, 1906, p. 322.

received the attention of these expeditions, I would refer only to that of the former land connection between India and Africa, and to that of the formation of the coral islands of the Indian ocean. It is now generally acknowledged that a land connection between India and Africa existed from Carboniferous to Tertiary times, when, probably by subsidence, it had been reduced to a narrow isthmus or chain of islands. The latter, by means of current erosion, were washed away until at present of all this great land bridge the Seychelles archipelago alone remains above water, while the higher portions of the remainder form the banks, on which many of the coral islands of the Indian ocean are built. In the course of the *Sealark* expedition almost all the islands of this ocean were visited, including Farquhar, Providence, and St. Pierre, the outlying islands of the Aldabra series, of which, however, they are not entirely characteristic. Aldabra itself, which is quite typical, has long been known as the last home in the Old World of the giant land tortoise (*Testudo elephantina*); it was also known to have a peculiar avifauna, and Dr. Voeltzkow, who visited it in 1895, reported that it was in part built of rhabdoliths and coccoliths.* In addition, analysis of samples of Aldabra guano showed abnormal percentages of iron, silica, and alumina, and the series of facts taken together seemed to show that the island must be very peculiar and perhaps even another remnant of the Indo-African bridge.

Further investigations were obviously desirable, and these were arranged by Prof. J. Stanley Gardiner, who, with Mr. Hugh Scott, was working on the geography and entomology of the Seychelles. My task was to visit all the islands of the series not examined by the *Sealark*, and to carry out extensive investigations on Aldabra itself, the result of which I am about to describe. Before doing so, however, a brief account must be given of the history of the region, though unfortunately it is small and relates solely to Aldabra. This island is first mentioned in the year 1511, and is called Ilhadara; it occurs afterwards on various Portuguese and Spanish charts under the names of Alhadara, Ya d'Arena, Y de Areo, and Adarno, all of which mean "sand-island," a name which, as will be seen later, is markedly inappropriate. Voeltzkow, however, makes the probable suggestion that the island was originally named Al-Khadhra—the Green—by the Arabs, and the Portuguese, misunderstanding the word, translated it phonetically to Alhadara, and so obtained the various names by which it has been known. Little written history is extant, but we know that during the French occupation of Mauritius it was often visited for the land tortoises, which were taken to the Mascarenes and Seychelles, where they were much esteemed as food. In recent times it has been visited

* 'Wissenschaftliche Ergebnisse der Reisen in Madagaskar und Ost-Africa,' Bd. II.

for scientific purposes by Dr. Abbot in 1893; by Dr. Voeltzkow in 1895; by a bird-collector for the Tring Museum; and in 1906 by the *Valhalla*.* These expeditions resulted in our knowledge of its more conspicuous forms of life, but owing to the extremely dense jungle, the above explorers were unable to visit the greater portion of the island in the time at their disposal. In 1907 Messrs. R. Dupont † and H. P. Thomassett visited Aldabra for short periods and obtained the samples of guano before referred to, and in addition, made a preliminary list of the plants. It will be seen, however, that Aldabra was not sufficiently known to be comparable with the other islands visited by the *Sealark*, and that from all points of view a further expedition was desirable.

With this introduction I will now turn to my own visit in 1908–1909. I arrived in Mahé in July, 1908, and, after a month spent testing my gear in the outlying islands of Bird and Dennis,‡ I left the Seychelles in the schooner *Charlotte* (Captain Parcou, F.R.G.S., master), and was fortunate in being accompanied on the voyage by Dr. Power, Visiting Magistrate for the outlying islands. On account of the south-east trade winds, which blow from April to October, the voyage was speedy, and in five days we sighted the island of Astove, the most easterly of the four islands to be visited. The current in these regions runs strongly (3 knots) throughout the year approximately from east to west, and as it is impossible for a ship to beat against both wind and current, we had, perforce, to touch at the most easterly island and work gradually westward to Aldabra. At Astove we stayed five days, but I shall defer the account of this island, as also of Cosmoledo and Assumption which we visited next, until I have described Aldabra, which we eventually reached on September 13.

Aldabra is situated in lat. 9° 22′ 25″ S. and long. 46° 14′ 41″ E., and therefore lies some 240 miles north-west of Cape Amber, and 600 miles south-west of the Seychelles archipelago. In form it is an atoll, with a long axis of about 24 miles and a short axis of from 5 to 10 miles, the long axis running approximately east and west. The land-rim measures some 60 miles in circumference, and averages a mile in width, though at its widest it is nearly 5 miles from lagoon to sea: it is divided by narrow passes into four main islands, which are called respectively Picard, lying to the north-west, Polymnie and Malabar, to the north, and Main or South island, completing the circumference from the north-east to the west. Round the outside of the land-rim is found a narrow fringing-reef, which is divided by the channels from the larger passes,

* 'Three Voyages of a Naturalist.' Nicoll.

† An account of the Aldabra group by Mr. R. Dupont is published in the Seychelles Government Reports for the year 1907.

‡ A short description of Bird and Dennis will be found in the *Trans. Linn. Soc.*, "Percy Sladen Trust Expedition," vol. 3, p. 15.

and is ill defined in the extreme east. The lagoon shore of the land-rim is overgrown with dense mangrove swamps, which at their greatest width measure about a mile. The lagoon itself is 15 miles long and averages 4 miles in width, and has an area of about 50 square miles, though owing to the presence of numerous small islands this estimate is probably somewhat inaccurate.

On arriving at the atoll headquarters were at once established on Picard island, on which is situated the main settlement of the group. It consists of a number of huts inhabited by negro labourers, who are hired in the Seychelles to work for a period in the islands. There is also a house for the manager (M. Moulinier), a store, and four large ongars for drying mangrove bark, of which industry more will be said later.

Owing to the kindness of M. A. D'Emmerez, who leases the island from the Seychelles Government, I was immediately provided with a large "dug-out" canoe, or *pirogue*, and a crew of six men, and at once left the settlement and journeyed to Ile Michel, a small island in the east of the lagoon, from which the first explorations were made. The general method employed was to cut main sectional tracks about 6 feet wide across the land-rim from lagoon to seashore, and then by smaller paths to explore the country on each side. The work was arduous, for the majority of Aldabra is covered with an extremely dense jungle of a tree, *Pemphis acidula*, which in most islands of the region is only found in small numbers. The wood is very hard and but little attacked by insects, but, unfortunately, the trees, though attaining an exceptional height for the species, are too small for timber. In addition to the jungle, a further obstacle to exploration is given by the surface of the land, which is rocky and seldom covered with soil; while under the influence of rain-water denudation it has been so eroded as to form a miniature rocky forest of points, pinnacles, and sharp edges, very formidable to men with bare feet. The Pemphis jungle and the eroded rock are always found together, and from the fantastic shapes taken by the latter the association is known in Creôle as "Champignon" country.

During the first two months the majority of the north of the atoll was explored, and Pemphis jungle alone met with. In November, when the south-east trade winds began to break, camp was moved to Main island, to a spot known as Takamaka, which is remarkable in possessing the only fresh-water springs on the whole atoll. The name is derived from a large clump of takamakas (*Calophyllum inophyllum*), and the country in the neighbourhood differs markedly from the Pemphis country, for the rock is more or less flat, and is covered with a thin layer of guano soil, while the jungle is open and varied, consisting of small clumps of trees divided by glades covered with low bushes. A month was spent at this camp, and the whole of the east of Main island explored. The calm season had set in, and the damp steamy

atmosphere following on the drought of the south-east trades caused all the trees, previously parched or even leafless, to burst into flower. Insects began to emerge in numbers, and the collections were considerably increased. In December a further move was made to Ile Esprit, in west of the lagoon, an island which possessed many peculiar features both geological and botanical. Thunderstorms, with heavy rainfall, were frequent. A dead calm prevailed, and the thermometer continually stood at over 100° Fahr., while the atmosphere seemed almost saturated. Under these conditions the difficulties of work were considerably increased, and it was fortunate that the majority of the stubborn Pemphis jungle had been explored in the cool south-east trades. January, the last month of my visit, was spent in the examination of Picard island, and the west end of Main island; much of the latter had to be accomplished from the seaward face of the land-rim, and the pirogue journeys to and from headquarters were attended by a certain amount of risk, for heavy squalls arising from any quarter were frequent, and the surf on the reef became dangerous in a very short time. Indeed, it speaks well both for boat and crew that no serious loss ever occurred.

At the end of January the *Charlotte*, having been becalmed for nearly three months, drifted to Aldabra, and as scurvy or an allied disease had broken out in the camp, it seemed wise to leave for Mahé.

Having now given some idea as to the distribution of time on Aldabra, I return to its nature and structure. The first point which should be emphasized in this connection is that the whole of the atoll is either of coral or secondary derivatives formed from coral reefs, for I was quite unable to find any rock which could be considered as part of the land connection between India and Madagascar. There are three main types of rock constituting the land-rim; the first forms a zone completely round the atoll, and is marked by the peculiarity that the majority of its component corals are obviously in the position in which they grew, thus showing that the atoll is a reef, which has been elevated in relation to the surface of the sea. The second form of rock is one in which the corals are broken, somewhat triturated, and mixed with such *débris* as mollusc-shells and broken lithothamnia; it is chiefly found in the east of the atoll, and was probably formed of the material washed by the current from the flourishing reef edge before the atoll was elevated. The third type of rock constitutes the majority of the inner portions of the land-rim; it is highly metamorphosed coral rock, which is peculiar in containing inclusions of calcium phosphate derived from the deposit of guano, which Aldabra, in common with most of the Indian Ocean islands, at one time received. It would hardly be supposed that calcium phosphate could induce or hasten metamorphosis in coral rock, but on account of the fact that it is contained in all the metamorphosed rocks of this particular region it seems probable that its

whole effect is not understood. It is this latter type of rock which, under the influence of rain-water denudation, has formed the "champignon" on which the Pemphis jungle is found.

These three types of rock constitute the land-rim, which as a whole exhibits the following characteristics. On its seaward face it ends in abrupt overhanging cliffs 12 to 15 feet high, which show plainly the effect of wave-erosion, for large masses are continually falling, and these are speedily broken up by the sea, their ultimate solid form being, apparently, sand. Beaches composed of the latter substance are scarce on the north coast, but more frequent on the south, where it can be shown in all cases that they are formed by the sea and wind piling the sand over the elevated coral rock. In this way have been formed large sand-dunes (Dunes Jean Louis and De Maistre) 50 to 60 feet high, which are the highest points on the atoll.

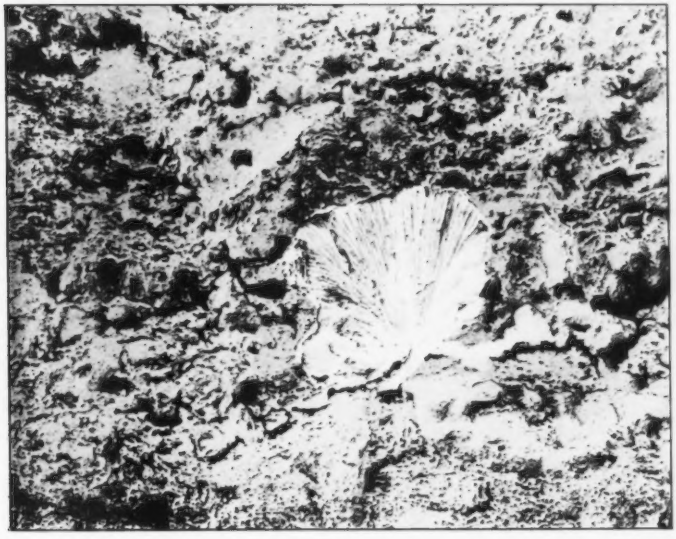
The coral rock itself reached a maximum height in the neighbourhood of the sea-cliffs, where it measures from 12 to 20 feet above the level of the sea; from this point it sinks gradually down to the mangrove swamp, where there is usually a sharp drop of 2 to 4 feet formed by low overhanging cliffs.

A most characteristic feature of the land-rim is the frequency of natural pits in the rock. Most descend below sea-level, and in this case usually contain salt water, which fluctuates with the tide. The rock of the land-rim, therefore, is so porous, or rather cavernous, that sea-water can penetrate it completely. The effect of erosion in these pits is always extensive, and they are, without exception, becoming larger.

Erosion, again, is obviously occurring along the whole of the lagoon shore, and it appeared that lagoon-erosion was even more rapid than sea-erosion, though the former must depend solely on solution, which in the latter is largely assisted by the powerful action of the waves. The explanation of this is probably twofold: first, the level of the land is low near the lagoon and high near the sea; and, secondly, the lagoon shore is clothed in mangrove swamp, the mud of which, charged with organic matter, naturally gives rise to carbonic and probably other acids. At each tide large quantities of fine mud are swept from the swamps out to sea, but so great is the disintegration of rock that enough mud is always formed to balance the loss. The sum total, therefore, of the forces at work on the land-rim is one of great loss: the sea is encroaching; the lagoon is encroaching; the pits are getting larger; the rain is dissolving away the surface of the land, and, to counterbalance all, there is only a slight piling of sand by the wind.

Turning next to the small islands in the lagoon, it was found that the majority were composed of metamorphosed coral rock, and all showed the curious mushroom shape characteristic of erosion by solution. Sufficient evidence was obtained to show that all at one time

ALDABRA: PICARD ISLAND SETTLEMENT. A CLUMP OF SCREW PINE (*PANDANUS VANDERMEESCHII*) AND SINGLE TREE OF *TOURNEFORTIA ARGENTEA*.



ALDABRA. FOSSIL CORAL IN POSITION OF GROWTH.

ALDABRA. A PIT OR BASIN IN THE ROCK CONTAINING SALT WATER (TIDALLY FLUCTUATING).

ALDABRA. LAGOON AND ERODED ROCKS. A PIROGUE IN THE FOREGROUND.

formed part of the land-rim, and therefore at least one half of the lagoon was formerly non-existent.

One island in the lagoon, Ile Esprit, deserves further mention. It consists of a crescent-shaped ridge of rock some 30 feet high and about half a mile in length, the whole being composed very largely of calcium phosphate. On the sides of the ridge are curiously shaped pinnacles and walls of a rock which seems to have been formed from a mollusc-bed, and which has suffered exceedingly from rain-water denudation. These formations were at first difficult to explain, but a clue was obtained on Picard island, where a large pit in the rock was discovered which contained minerals, even more interesting petrologically, yet obviously of the same formation. It appears, then, that the whole of the ridge of Esprit has been formed in a large subterranean cavern or pocket, to which guano or a solution of its chief constituents at some period obtained entrance, and became a solid mass of phosphatic rock. The whole question was of great interest, as it proved that the level of the land at one time was higher than the top of Ile Esprit, that is, over 30 feet above sea-level, and that therefore the lagoon is a recent formation which did not exist when Aldabra rose above the sea and became land.

At the present day the lagoon exhibits the following features: the bottom is muddy towards the outsides and sandy in the centre; channels from the passes radiate into it, and are deep (10 to 14 fathoms) at first, but soon become as shallow as the rest of the lagoon, which is only just covered with water at low spring tides. Judging from the survey by Ad. Wharton in 1878, there is evidence that the lagoon is gradually deepening, but the process is slow on account of the rapid production of sand and mud by the disintegration of rock round the shore. Living coral is scarce, and only forms definite reefs just inside the passes, where it is exposed to the full force of the tidal currents; elsewhere the water is too foul, on account of mud in suspension, and indeed for this reason marine life generally is scarce on Aldabra.

Conditions in the lagoon are governed to a large extent by the number and size of the passes, about the formation of which a few words may be said. A glance at the chart will show that sea-erosion progresses evenly over any stretch of coast, while lagoon-erosion is extremely irregular and has cut up the lagoon shores into long creeks, sharp headlands, and small bays. As a natural corollary, it follows that fresh passes are formed by the lagoon, and not by the sea. All stages of pass-formation are shown on Aldabra. At Camp Frigate, on Malabar island, the mangrove swamp has passed through the land-rim to the sea, and it remains only for the lagoon to dissolve away a little more rock in order to allow a powerful current to sweep through at each tide and form a new pass. The next stage is represented by the western channels between Picard and Main islands, where the passes

are quite open, but have not yet attained a passage through the fringing reef. A complete pass can be seen in either Grande Passe or Passe Houareau, where a deep central channel connects the lagoon through the fringing reef to the sea outside. A further feature of the older passes is that they are bounded on each side by a reef exactly resembling the fringing reef surrounding the whole atoll. This pass-reef evidently consisted of land (elevated coral rock) cut down to low-tide level by erosion, and then piled with broken coral and partly colonized by living calcareous algæ (*Lithothamnia*), which together prevent further rapid loss. The clue thus obtained was applied to the main fringing reef, which had previously been noticed as being extremely barren and dead, and no doubt remained that it also consisted of a ledge of coral rock, the foundation of land washed away by the sea. The fringing reef, therefore, is not a sign of the growth of the atoll seawards, but, on the contrary, owes its origin to erosion. The edge of the reef has been largely colonized by Lithothamnia, and to a certain extent by corals, but these, though possibly preventing further loss, probably only retard the action of the sea in removing the rock. On the other hand, it should be noted that unfavourable conditions for life, such as are caused by the mud from the lagoon, need not always continue, and that therefore the rock ledge of the fringing reef may in time form a base to support coral growth.

In summary, it may again be emphasized that the atoll is losing on all sides in its fight with the sea, the only gain being in a tendency to pile sand in certain places, a tendency which must be remembered when the atoll of Cosmoledo is considered.

At this point I must leave the general structure of Aldabra and say a little about its biology, though for obvious reasons only a few of the more general features can be mentioned.

The flora is remarkable in that the plants are not such as are usually found on coral islands. The metamorphosed rock, uncovered by soil, is no doubt unfit for the vegetation which flourishes on coral sand, and consequently various plants of Malagasy origin have been given the chance of colonizing the atoll. Several of the latter * are often supposed siliciphilous; but it seems probable that the idea is mistaken, and that they would be found on many of the coral islands of the region were it not that the coral sand vegetation is dominant and exclusive.

Œcologically, the following types occur. There is first the Pemphis jungle, which is composed largely of *Pemphis acidula*, with scattered trees of other species not yet determined. The Pemphis plant varies from 10 to 15 feet in height, and consists of a short thick trunk, from which a number of tall thin branches arise. With its narrow pinnate leaves of a bluish-green colour, a single plant is not unlike a willow;

* Cf. members of the Rubiaceæ and Sapotaceæ.

but in the jungle the trees grow so close together that the whole is rather reminiscent of a continuous well-grown whitethorn hedge. Herbaceous plants are very scarce in this jungle, though a mistletoe (*Viscum*) is not uncommon as a parasite on the Pemphis, and is much esteemed as a medicine by the negroes.

The second type of vegetation is found in the "open country," and is composed of some ninety species of trees, shrubs, and herbs. Small clumps, composed of Pandanas, Ficus, Dracœna, alternate with open glades, sparsely covered with low bushes, among which the Tanghain (*Euphorbia abbotti*) is conspicuous. Many of the trees and bushes lose their leaves in the dry season and commence to bud in November, while herbaceous plants and grasses disappear or dry up, and only become green after the first rains. With the exception of becoming deciduous, the trees do not seem to have specially adapted themselves to a dry season, and indeed several appear to have well-developed "drip-tips," which, though unnecessary in their present habitat, were no doubt of service in their original home, Madagascar. The next region is the Mangrove swamp, a form of vegetation too well known to need description. It contains three genera of Rhizophoraceæ and four of so-called "pseudo-mangroves," the latter being plants other than members of the above family, which have assumed the habit of mangroves; they are unimportant, and occur chiefly in a few localities, which are too sandy for true mangroves. The mangrove forest is very flourishing, and clumps of Bruguiera 60 feet and over are not uncommon, though it is remarkable on coral islands to find even a few scattered trees; the explanation probably lies in the fact that the lagoons of most atolls are too open to allow of the accumulation of mud.

The chief industry of Aldebra is connected with the mangrove swamp, and consists in the removal and drying of the bark of the genera Rhizophora and Bruguiera. The bark is obtained by beating it from the wood with a mallet; it is carried to the settlement and dried on trays, and then, after the outer cuticle has been removed, is ready for export. If the bark has been carefully prepared, it contains a high percentage of tannin, and is of considerable value. The atoll possesses a very complete outfit for the work, but owing to wasteful methods but little profit can be obtained, and the forests are being ruined. If the trade is to remain a permanent asset, stringent regulations will have to be made concerning the proper removal of dead trees after barking, for the latter take years to rot away, and effectually prevent young trees from growing up. In former times mangrove timber was of value in Mauritius; if this is still the case, a contract might be obtained for a quantity, and the barked trees would then pay for their removal and perhaps contribute towards the profit to be gained from the forest. The final type of vegetation may be termed "coast scrub," or "shore zone"; it occurs in those parts of the atoll

where sand has been blown up from the reef, covering the rock and forming a little soil. The plants are such as are usually found on coral sand islands, Tournefortia * and Scævola † being familiar types. A few coconuts have been planted in the sandy soil of this region, but up to the present seem likely to be somewhat dwarfed. In the wet season vegetables could certainly be grown, and would undoubtedly improve the general health of the settlement, which at present suffers from an absolute lack of green food and the diseases it entails. Agriculture as a whole can never be of primary importance; but there is no reason why it should not be made to yield a small profit, and at the same time it would make the atoll a much more habitable place.

The animals of Aldabra are not numerous, though the land fauna is perhaps greater than on most of the coral islands of the Indian ocean. The explanation of this lies, firstly, in the fact that the type of vegetation is unusual; and, secondly, in that continental land is distant only 250 miles, while the size of the atoll must be of assistance in intercepting wind or wave-swept animals. The nature also of the land fauna is peculiar, for many species of wide distribution on coral islands are absent, while among the smaller forms, especially among the insects, a continental facies obtains, the genera in most cases being identical with Malagasy forms. It is interesting, therefore, to note that as the vegetation is derived from Madagascar, so the fauna has a like origin, and I have little doubt but that if the island was sandy instead of rocky we should only find widely distributed plants and widely distributed animals.

Turning to a few of the more interesting forms, I would mention first the giant land-tortoise (*Testudo elephantina*), which still occurs in some number in the east of Main island, and is to be found, though not commonly, throughout the rest of the atoll. It perhaps seems scarcer than it really is, for it is of such a shy and retiring disposition that it would be possible to live for years on Aldabra and never see a specimen. The day is spent hidden in the densest jungle, a clump of Pandanus being a favourite haunt; at night the tortoises leave their shelter and go in search of food, which consists of leaves and grass in the wet season, and, it is said, of bark in the dry, though a small succulent, occurring throughout the year near brackish pools, is greedily eaten. Breeding takes place in February and March, when a hole is dug in some guano-filled pit in the rock, and in it the hard-shelled eggs are laid. Incubation is stated to last sixty days, but unfortunately I had to leave the atoll too early to make any observations on their breeding habits.

A proposal has recently been made to remove the whole stock from

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* *Tournefortia argentea.* † *Scævola koenigii.*

ALDABRA. LAGOON AND ISLAND NEAR ILE ESPRIT (ON THE HORIZON THE MANGROVE SWAMP OF MALABAR ISLAND).

ALDABRA. PICARD ISLAND: OPEN OR VARIED TYPE OF JUNGLE.

ALDABRA. MANGROVE SWAMP.

ASSUMPTION. WIND DUNE 90 FEET HIGH, LANDWARD SIDE.

Aldabra to the Seychelles in order to prevent their extinction; in my opinion this precaution is unnecessary, for, in the first place, there are already several herds of tortoises on the Seychelles (*e.g.* on Felicité), and in the second, it does not seem that the tortoises on Aldabra are in imminent danger of extinction, provided that the green turtle continues to form an abundant and easily obtained food for the settlement. If the tortoises at present have an enemy it is probably the rat (*Mus rattus*), which, escaped from ships, is a plague to the atoll.

The distribution of land-tortoises in the Indian ocean seems worthy of mention. They have occurred on the Seychelles, St. Pierre, Cosmoledo and Assumption (where I found their bones), Aldabra, the Mascarenes, and Madagascar. It may be supposed that they reached continental islands, such as the Seychelles, by land; but this cannot apply to islands of purely oceanic origin, such as Aldabra, which from its structure can never have had any continental connection. They do not belong to the class of animal which is distributed passively by the sea, and therefore it appears that they must have been brought by human agency. The fossil tortoises found on Assumption and Cosmoledo, and also bones embedded in rock on Aldabra, force one to the conclusion that this transportation by human agency must have taken place in extremely early times, if indeed, as I am inclined to think, they do not preclude it altogether, and I must confess that we know nothing as to the means by which so many of the islands of the South Indian ocean were peopled by giant land tortoises.

I next pass to another Chelonian, the green turtle (*Chelone mydas*), an animal which is of considerable economic importance to the atoll, for it still occurs in the vast hordes which are so often described by early voyagers in the tropics. There appear to be two distinct groups—one resident and small in numbers, the other migratory and visiting the atoll to breed in numbers impossible to estimate. The latter arrives in December, and from then to April the sea seems alive with turtle. The females seek the small sand-beaches, and then ascend them with the rising tide, pushing themselves laboriously above high-tide mark. Holes are then dug in the sand by means of the fore-flippers until a satisfactory one is obtained, and the eggs, 200 in number, are buried, the turtle returning to sea with the next ascending tide. After forty days the eggs hatch, almost simultaneously, and the young turtles dig their way up out of the sand and go down to the sea in a long procession, in the course of which they offer an easy prey to their enemies the frigate birds and herons. Once in the sea, sharks and other large fish eat them, and it has been stated that only ten per cent. reach maturity. Turtles are captured by spearing from a pirogue, and by turning the females on the beach. A certain number are kept alive and are sent to Mahé, but the majority are killed, and the connective tissue under the carapace and plastron, after boiling, is the calipee of commerce, which forms the basis

for turtle soup. The meat also is dried and is known as quitouze, a substance which has considerable sale in the Seychelles and Mauritius. Next to the mangrove industry the trade is the most important on the atoll, and it is a matter of regret that, owing to wasteful slaughter, there is a great possibility that the turtles will be speedily reduced in numbers or even killed out (so far as trading purposes are concerned). On account of the distance of Aldabra from the Seychelles, the seat of government, regulations limiting the number to be killed are likely to be of little effect, but something might be done to ensure a plentiful supply of young turtles. The period of greatest danger in a turtle's life is during the first six months, through which, however, they can be easily reared in small turtle ponds or even large tubs. A regulation might be made, applying to all the islands on which turtles breed, to the effect that the managers should every year rear to a certain size (4 to 6 inches long) a definite number of turtles (the number to be assessed in proportion to the number killed). The magistrate, who visits the islands annually, should have the young turtles counted, and those over the required size could be liberated. If the number was under the assessment a substantial fine could be imposed, while a reward might well be offered for any over the number. It would thus be ensured that a reasonable number of turtles would have a chance of attaining maturity and preserving the race.

The tortoise-shell turtle (*Chelone imbricata*) still occurs sparingly in the lagoon round the shores. It is much sought after, those which have lived for some time in the lagoon being especially valuable, as the shell becomes covered with mud, which prevents the development of dark markings. Unlike the green turtle, the hawksbill lays its eggs in the day, and the incubation period is longer, while there are several minor differences in habit which need not be mentioned here. The majority are caught by spearing, though a few are turned on the beach. To remove the shell the body is buried in the sand for two or three days, when the plates can be removed and are then ready for shipment to Europe.

The birds next merit a few words, for they undoubtedly are a prominent feature of the atoll. There are twelve species of land-birds, all peculiar to Aldabra, and a fair number of widely distributed sea-birds and waders. The land-birds are all related to the Madagascar species, and their origin is doubtless thus indicated. Most characteristic, perhaps, is the ibis (*Ibis abbotti*), a handsome black-and-white bird closely resembling the sacred ibis of Egypt. In habit it is tame, stupid, and extremely inquisitive, and at Ile Michel and Takamaka played the part of camp scavenger; it breeds in colonies in the mangrove swamp, and as the trees used become trampled down and flattened, it is probable that the same trees are used year after year. The eggs, two in number, and of a whitish colour, are laid on a slight nest of sticks, on which they

rest but insecurely, with the result that a large percentage of the eggs are rolled off by the birds, which always alight on their nests most clumsily. Another bird worthy of specific mention is the peculiar rail (*Dryolimnas aldabranus*) which was said, though incorrectly, to be flightless. It is the only bird of the Pemphis jungle, and lives on small insects and also crustacea from the brackish pools. Its call consists of a single note like the beat of a native drum, followed by a long whistle, which Nicoll in 'Three Voyages of a Naturalist' compares to the screaming of a drove of pigs. With its pretty plumage and confiding ways it is a very attractive bird, and was always welcome in the camp.

Of birds not peculiar to the atoll I would mention the frigate (*Frigeta aquila* and *F. ariel*), gannets (*Sula leucogaster, etc.*), egrets, and flamingoes, all of which, either by their habits or plumage, form distinctive features in the scenery. The frigate (chiefly *F. ariel*) occur in numbers I have never seen recorded elsewhere; they are almost entirely parasitic on the gannets, which they force to disgorge, and though young turtles are readily eaten, they seldom fish for themselves. The name Camp Frigate is taken from the enormous colony which breeds in the swamp there. Curlews and especially whimbrel are common in the mangrove swamp, and I also noticed among other waders turnstones (*Strepsilas interpres*) and sanderlings (*Calidris arenaria*), the latter being perhaps the greatest wanderer of all birds.

Of other vertebrates reference can only be made to the fish, on account of their possible economic importance. Dried fish has a ready sale in the Seychelles and elsewhere, but in Aldabra it is impossible to use a net, and consequently, though fish are very abundant, the profit which can be made is small. In speaking of fisheries, it may be well to dismiss pearlshell and trepang (*Holothuria, sp., Actinopyga, sp.*), both of which are found in the lagoon. The pearlshell only reaches a small size, and the edible trepang is scarce, and therefore a trade in these animals cannot be developed on any scale.

A detailed account of the invertebrates will be given elsewhere, and I will conclude the description of Aldabra by a reference to the mosquitoes and a curious epidemic of malaria which occurred. The mosquitoes are all of the genus Stegomyia, and swarm in such a manner as to make certain places, as for instance Takamaka, practically uninhabitable; it may, indeed, be confidently stated that in the wet season day or night in any part of the atoll there is never a moment when one is not being attacked. The genus Anopheles is entirely absent, and it might be expected that malaria would be also unknown, but this is not the case, for in 1908 a curious epidemic occurred, which is almost undoubtedly to be ascribed to this disease. On account of its importance, the history of it may be given in some detail. In March, 1908, there arrived a ship carrying Malagasy labourers from Nossi-Bé,

Madagascar, a locality noted for malaria. In about three weeks many of the negroes began to suffer from attacks, which corresponded exactly with tertian ague; during May, June, and July the number of cases rapidly increased, and several were sent to Mahé, where Dr. Addison * confirmed the character of the disease by the examination of blood-films. Dr. Power also considered the disease malaria, and indeed, from the blood-films, the periodicity of the attacks, and the yielding of the disease to quinine, I feel no doubt that the diagnosis is correct. During August, 1908, the number of fresh cases began to diminish, and the last fresh case occurred at the end of September, while at the end of January, 1909, the atoll was free from the disease. On my arrival I searched with the greatest care for Anopheles either in the larval or imago stages, and I feel confident it does not exist on Aldabra. The explanation of the epidemic, I would suggest, is, that though it is proved that Stegomyia is not a host for the malaria parasite, yet that it can convey it passively —that is to say, if a Stegomyia bites a patient suffering from an attack and then bites an unaffected person, it is possible for the latter to contract the disease, for in the act of sucking a little of the blood (containing sporulating malarial plasmodia) of the infected person will be injected into the unaffected. This explanation also accounts for the decline and extinction of the disease, for in the absence of the Anopheles no sexual processes are possible, and the stock of the protozoan will become senescent and die out.

At this stage, having given an account of the more general features of Aldabra, I will more briefly touch on the characters of the other islands visited.

Assumption island I touched at both on the outward and homeward voyages, but each time my stay was short, and I had time to study only its main geological and geographical features. The island, which is not an atoll, lies about 20 miles south-east of Aldabra; it measures $3\frac{3}{4}$ miles long by $1\frac{1}{3}$ mile wide, and has a maximum rocky elevation of 20 feet, which is found on a ridge running along the west coast about 250 yards from the sea, the remainder of the land being some 12 feet above sea-level. The shore on the west coast consists of a sloping sandy beach, but the greater part of the island is bounded by cliffs like those of Aldebra, which Assumption resembles in most points, for it is an elevated coral reef composed of the same classes of coral rock, which form the land-rim of that atoll. Pits in the rock are even more common than on Aldabra, and are usually in connection with the sea; they are all growing larger by erosion, and are gradually interconnecting. If, now, the island at the time of elevation had been basin-shaped, the pits in the interior would connect together more quickly than those towards the outsides, and a lagoon would be formed; as it is, the island will

* Chief medical officer.

gradually be split up into a number of isolated rocks, may disappear altogether, or form a foundation, on which a sand cay can be piled (cp. Providence). To the south-east of the island is a series of large sand-dunes (90 feet high), to seaward of which there is no definite fringing reef, though the water is shallow for some distance (1 mile) from the land; it appears probable that this shoal represents the site of land which has been cut down by sea-erosion, while the sand-dune is formed of sand produced in this process. Assumption, therefore, was once considerably larger than it is now.

The surface of the land is less bare than on Aldabra, as it has received a large deposit of guano, which, along the east coast forms a narrow plain, and in many cases has partially choked up the pits in the rock. Exportation of this guano has commenced, and the prospects, superficially, appeared to be decidedly favourable.

The island is covered with low tangled vegetation, composed mainly of Aldabra plants, among which Tanghain (*Euphorbia, sp.*), Liane, caoutchouc (*Astephanus arenarius*) are conspicuous, while the rocky pits are often fringed with banyan (*Ficus, sp.?*) trees, the long roots of which pass right down to water (salt), and form a network of natural ropes, which were most convenient in examining the lower levels of the rock.

Animals are not so numerous as at Aldabra, but comprise several distinct species. The bones of land tortoises were found in the pits on the rock, but the animals are extinct at the present day. Green turtles are even more numerous than at Aldabra, for the sand-beach along the western shore forms an ideal place for the females to lay their eggs. Here again, however, wasteful slaughter is lessening their numbers, and it will never again be possible to catch two hundred in one night, as was formerly the case.

Birds are not so numerous as at Aldabra, but comprise certain species of cuckoo, rail, pigeon, and gannet which are stated to be distinct. In one of the pits I found an eel, which Mr. Tate Regan describes as the type of a new family. Mr. Dupont, who spent a month on the island recently, has very kindly sent a collection of insects, which contain several species not obtained by me.

The settlement, which is built to the north of the west coast, was founded in June, 1908. The great difficulty has been to obtain fresh water, though a well in the sand near the settlement yields a small supply of slightly brackish water, which, with what can be collected during the rains, is nearly enough for drinking purposes for the settlement. Calipee, however, cannot be properly made without a plentiful supply for boiling purposes, and thus a large amount of turtle is wasted. After the guano has been dug, no doubt the settlement will be much decreased, and the water-supply may then be sufficient for all purposes.

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The third island visited was Astove, which lies some 60 miles south-east of Assumption. It is an atoll 2 miles long by $1\frac{1}{5}$ miles * wide, and is characterized by having a very perfect land-rim, which is only divided by one pass. It is undoubtedly an elevated coral reef, and corals in position of growth are very evident, not only on the rocky cliffs, but also on the surface of the land, where fields of fossil corals can be found uncovered by soil, each colony retaining its position and its characteristic features. Conglomerate rock is scarce, and is only found near the lagoon, a distribution which also applies to the metamorphosed rock, which, as at Aldabra and Assumption, always contains a certain amount of calcium phosphate.

The lagoon, though obviously increasing in size, was probably present before elevation, thus differing from the lagoon of Aldabra which is entirely of secondary formation. The pass is apparently of very recent date, for it is small, has no channel, and is almost dry at low tide. The fringing reef outside the pass is also unchannelled, though the rush of water from the lagoon as the tide descends has prevented the piling of coral *débris* on the reef flat, which is formed of elevated coral rock, thus showing that the fringing reef has been formed by land being cut down to low-tide mark by sea-erosion.

Animals were but little collected, and though the Assumption rail † was noticed, birds seemed rather scarce. Turtles are numerous, and are caught in considerable number for calipee. Entomologically, Astove appeared rich, and it was a matter of regret that no collecting could be done there. The island is mainly covered with low bush, though a few strips of jungle not unlike Aldabra Pemphis scrub occur. Owing to the presence of sand blown up from the lagoon and reef, Astove is considerably more fertile than the islands previously mentioned, and fair crops of maize, tobacco, and vegetables are grown, while a plantation of coconuts gives some promise of success. Guano occurs in pits in the rock, and also along the lagoon shore, and as the quality appears good, it will no doubt be worked in time. The people of Astove differ from those of the other islands in being more or less permanently resident; they are more inclined towards agriculture, and grow considerable crops on the share system.

Cosmoledo, the last island visited, lies 20 miles north-west of Astove, which it resembles in being of atoll formation. It is 9 miles long and 7 miles wide, and, unlike Aldabra or Astove, the land-rim is very imperfect, not more than one-half the atoll circumference being capped with land. In formation Cosmoledo is a typical elevated ‡ atoll, the rocks having the same composition as those constituting the land-rim

* The survey appears to be inaccurate.

† *Dryolimnus abbotti*.

‡ Maximum rock elevation is 15 feet above sea-level on Great North-East island.

of Aldabra, though the proportion of metamorphosed rock is larger. All the islands show signs of great erosion both on their seaward and lagoon shores, and judging from the number of rocks and small islands, I have no doubt that the land-rim was once as complete as that of Aldabra.

The reef between the islands is certainly based on elevated coral rock, and, though carrying no flourishing coral growth, was well protected by vigorous lithothamnia, so that, if not extending seawards, it was at least stationary. The lagoon was deeper than that of Aldabra, but I saw no extensive coral growth, which is perhaps accounted for by the presence of much sand.

The more important islands consist of Menai in the north-west, Wizard and Polyte in the south-east, the two North-East islands, and South island. All are conspicuous for the amount of sand which has been piled on to them by the sea and wind. On Wizard the coral rock only shows in places, and as this is the island which has suffered most from erosion, it appears that as rock land is removed it is practically replaced by sand, the latter being probably formed from disintegrated rock. The vegetation of the atoll has altered in relation to its change of surface, and though plants of the Aldabra type still occur, coral-sand plants are predominant. South island, however, which is rocky, and on which I was unable to land, seemed to have a vegetation not unlike Aldabra Pemphis jungle. The presence of much sand allows of a fairly extensive cultivation; young coconut trees on Menai appeared healthy, though small, and the crops of maize under the circumstances were promising both on Menai and Wizard. Guano formerly existed on the North-East islands, but the best has already been exported; Goëlette, Polyte, and perhaps South island still carry a considerable quantity.

When digging guano on North-East island, eggs of the giant land tortoise (*Testudo, sp.?*) were found in phosphate rock underneath the guano, thus showing their presence in former times on Cosmoledo.

Green turtle are numerous in the season, and owing to a fair supply of water on Wizard calipee can be made in quantity. A small mangrove swamp exists on Menai, but the large trees have already been barked. In time there will be a fresh supply from the young trees now springing up, but owing to the encroachment of the sea this swamp is bound to disappear. The main settlement is on Menai, and there is a smaller camp on Wizard. With a capable manager Cosmoledo should have considerable possibilities.

Of the other islands of the region little need be said, for I was unable to visit them myself, and they were all explored by the *Sealark* expedition. St. Pierre seems strictly comparable with Assumption, and Providence is a sand cay and may be taken perhaps as prophetic of the future state of the two former islands. Farquhar alone deserves fuller

attention, for it appears to represent a later stage in the life-history of an atoll as illustrated by Aldabra and Cosmoledo. It lies 180 miles east (east by south) of Cosmoledo, and is a large atoll 11 miles long, 5 miles broad. It is marked by the fact that only a small portion of its circumference is capped with land, which itself is characterized by being composed of piled sand, and not of elevated coral rock, which is scarce, though enough exists to show that the base on which the sand cays have been piled is an elevated reef. The lagoon is deep in comparison with that of Cosmoledo, and the atoll reef shows signs of a definite growth seaward. All these features are an advance on the Cosmoledo condition, just as Cosmoledo was an advance on the Aldabra condition, and before concluding I will attempt to illustrate this point briefly by giving what I consider to be the life-history of Aldabra, basing my account on the facts observed in the various islands of the region.

Before a coral reef can form, it is necessary for there to be some base, such as a mountain-top, which extends to within the limit of coral growth (40 fathoms). In the case of Aldabra, we know nothing of the nature of this base. It arises from a depth of over 1000 fathoms, and therefore perhaps is unlikely to be a remnant of the Indo-African bridge. On the other hand, the Comoros to the south-west are volcanic, and the *Sealark* dredged volcanic mud off Providence to the east (east-north-east), and therefore there is no inherent improbability in the existence of volcanic action in between. Without expressing any definite opinion, we will suppose tentatively that the base is in the nature of a volcanic mound. This was colonized by corals, which gradually built up a reef until it nearly reached the surface; its shape was probably that of a shallow basin, for both theoretically and from the geology of Aldabra it is likely that the corals on the outside were flourishing, and on the inside only weakly growing or dead. Next came the elevation of the atoll in relation to the surface of the sea, and the extent of this must be placed at from 50 to 80 feet. The method by which it occurred is not known, though it might be supposed that a slight local elevation would best account for the facts. It must be taken into consideration, however, that there is evidence throughout the southern Indian ocean of an elevation of about an equal extent, and it is difficult to conceive of an elevation of the earth's crust which would be so uniform over such a large area. The only alternative is a drop in the level of the ocean, and it may be mentioned that this is not entirely impossible. It has been shown that large land masses exert sufficient attraction to disturb the level of the sea, as an instance of which it may be mentioned that the level of the sea at Karachi is many feet higher than the level of the sea at Colombo, this being due to the attraction of the Himalayas. The last great changes in the land masses of the world took place in late Miocene times, and these

COSMOLEDO. WIZARD ISLAND: SAND-DUNES (60 FEET) AND CROP OF MAIZE.

may have so affected the level of the Indian ocean as to elevate all its islands many feet. It is with some trepidation that this question is raised, for it is matter rather for the geologist than the biologist, but my excuse must be that it is of great interest and bears directly on the subject in hand.

Returning again to Aldabra, in whatever manner the reef was elevated, there is no doubt that it came to stand over 40 feet above the level of the sea, and that at this time there was no lagoon in the centre, both of which points are clearly shown by the formation of Ile Esprit previously described. Next, sea-birds must have colonized the island in enormous numbers, for we know that large quantities of guano were deposited on it and were included in the rock during consolidation and metamorphosis. Rain-water denudation commenced to wear down the island in the earliest times, reducing its level exactly as it is doing at present. In the "post-elevation" history of the atoll the most important event was the formation of the lagoon, which may be supposed to have taken place as follows:—

Pits and subterranean cavities in the rock are common even at the present day, and must have been more so in early times; owing to the porous nature of the mass as a whole, tidal water penetrated these cavities, which naturally increased in size. Now, as the original reef was basin-shaped, the pits in the interior could interconnect first, and these obtained an opening through the higher rim of the atoll by means of Grande Passe (the oldest pass), which originally, perhaps, represented a line of weakness owing to subterranean caverns. Once the sea obtained a free entrance it hollowed out a lagoon inside, leaving only Ile Esprit on account of the superior hardness of its rock: rain-water denudation reduced the common level of the land, and thus we can easily arrive at the conditions found at the present day.

In the future we can safely prophesy continued loss until much of the land is washed away and only a few islands left on the atoll rim, separated from each other by stretches of reef, which, it must be remembered, consists in reality of elevated coral rock cut down to low-tide mark. The islands doubtless will lose much of their rocky character and be piled with sand, which is produced so abundantly in the progress of rock disintegration. As the land-rim disappears the lagoon, no longer made shallow by the constant formation of mud, will grow deeper, and for a similar reason the water both in the lagoon and outside will become purer and allow coral growth to flourish. Finally, elevated coral rock having almost disappeared, the islands mere sand cays, our atoll will resemble Farquhar, and beyond this stage it is impossible to foretell. The atoll bank may be cut down completely below sea-level, but, assuming the constancy of general conditions, it is more probable that the atoll reef will hold its own against the sea and carry the sandy islands which are so frequent in coral reef regions.

In concluding this paper I must express my deep sense of gratitude to Prof. J. Stanley Gardiner, to whose teaching and assistance any success gained by the expedition is due. I am also much indebted to His Excellency W. E. Davidson, Esq., for much kindness and hospitality; to M. A. Demerez, for leave to visit his many islands, and for placing all on them at my disposal; to Captain Parcon, F.R.G.S., whose knowledge was of the greatest service; and to Messrs. Fare and Newsam, for their hospitality and assistance in forwarding my baggage. Finally, I must tender my thanks to the Master and Fellows of Gonville and Caius College for electing me to the Shuttleworth studentship, and thus enabling me to undertake the work of zoological research.

The PRESIDENT (before the paper): It was in the year 1905 that an expedition, known as the Percy Sladen expedition, was organized for the purpose of visiting a number of islands in the Indian ocean. The special object of that expedition was to investigate the probability of there having been in past times a land connection between India and Africa. During this expedition, which was under Prof. Stanley Gardiner's guidance, the whole of the work could not be completed, and a second expedition went out subsequently in order to complete the work. With that expedition went Mr. Fryer, who was detached to investigate one of the islands in the Indian ocean which has very seldom been visited—the island of Aldabra. Mr. Fryer is the research student of Caius College, Cambridge, and is interested in those broad geographical problems which necessitate the study of the countries visited from zoological, geological, and other scientific points of view, problems which he is eminently suited to discuss.

Prof. STANLEY GARDINER (after the paper): Before alluding to the most interesting paper which Mr. Fryer has given us, I think that I must refer to the death of a very distinguished Medallist of this Society, who took a very keen interest in these explorations. Needless to say, I refer to the late Prof. Alexander Agassiz, whose loss to Oceanography has been of such serious moment. Prof. Agassiz visited practically all the coral regions of the world, except those to the south-west of the Indian ocean, and he took an extraordinarily keen interest in this expedition which I organized down to these regions. The future will, no doubt, estimate the value of Prof. Agassiz's work, but for myself, as I followed him in several regions, I know full well what a tremendous mass of evidence he accumulated about the tropical oceans of the world and about their coral formations. Fortunately, too, he has placed his rock specimens from all the different coral islands in that munificent building which he has given to Harvard University, the Museum of Comparative Zoology. Writing to me only in 1906 and 1907, he regretted the fact that we were unable in the *Sealark* to visit Aldabra and Assumption. He himself, and I agreed with him, thought that very likely in Aldabra we should find a barrier reef island, and not an island purely of coral formation. The peculiar plants and animals that came from that island suggested that it was of some other formation, and not coral limestone. The description of the whole island itself was so meagre that we did not even know it was "elevated" in any way. One expected to find some central volcanic mass or indications of such. Prof. Agassiz suggested the possibility of a reef which had been formed by subsidence, but, as Mr. Fryer has shown, Aldabra falls into line with most of the other reefs in the Indian and Pacific oceans. Prof. Agassiz, with his characteristic energy, even at his age, took into serious consideration the question of himself going

to Aldabra; this well shows his indomitable energy and his great keenness for these researches. He wrote to me in respect of Mr. Fryer's results, which I communicated to him, and said he considered Mr. Fryer had "well conceived his investigations, ably carried them out, and got results of great value." Mr. Fryer conceived his own investigations. He started them, and was not directed in any way, and I most cordially agree with every word Prof. Agassiz has said.

There are several new points to which one might be allowed to draw attention. One of the most interesting of these is Mr. Fryer's suggestion that mangrove roots have had an important effect in disintegrating coral rock. This suggestion is entirely novel. From the specimens which I have seen, it certainly seems to be the case at Aldabra, but it does not apply to coral reefs in general. Mr. Fryer pointed out that the Aldabra plants are not generally coral reef plants at all, and mangroves do not grow together into vast swamps in the lagoons of typical coral atolls.

With regard to the land plants of Aldabra, in opposition to Mr. Fryer's view, I am inclined to offer a different suggestion as to the real cause of these plants being so different to those of coral islands in general. I have had analysed coral sands from such islands, and there is singularly little or no phosphorus in them. In some guano islands of coral formation to the north of Mauritius, Cargados Carajos, were only found some fourteen or fifteen different kinds of plants, instead of the fifty to sixty commonly growing on coral islands. As a matter of fact, plants could not reach Cargados from Mauritius, and would have to come mostly from Australia or the East Indies. I suggest that it is due to the phosphorus in the soil that the ordinary coral plants are not able to live in Cargados, and not to difficulties of seed distribution. For the same reason, the regular coral reef plants would not grow in Aldabra, but other plants suitable to a phosphatic soil could arrive from the relatively near African coast and the islands of Seychelles, Mauritius, and Madagascar.

Mr. Fryer has shown certainly that Aldabra is not a part of the ancient land connection between India and South Africa, but there is the problem of the distribution of the land-tortoises which has been so frequently referred to by writers on geographical distribution. It seems to me, with the progress of zoological knowledge, that it is not a great difficulty to suppose that really all these tortoises in Mauritius, in Seychelles, and in other places, are derived from marine ancestors. Independently of these islands being on the supposed site of an ancient land-connection, is there any reason why such parallel or convergent evolution should not have taken place?

In respect to the "elevation" of Aldabra, Mr. Fryer drew attention to the attraction of land-masses, and I think the estimate of the height of the surface of the ocean from the centre of the Earth was 300 feet at Karachi, as compared with Ceylon, and not 30 feet, which perhaps he mentioned by a slip. It has also been estimated that, taking Hawaii in contrast with the Andes, there is a difference of over 1000 feet. But the greater part of the true oceanic coral islands is only raised about 30 feet above the sea, and I think that there is quite a sufficient accumulation of ice and snow on the Antarctic continent to account for such a difference in level. However, Aldabra certainly has been elevated more than 30 feet. Mr. Fryer suggested about 60 feet, while, judging from Prof. Agassiz's work in Fiji, his suggestion would be about 120 or 150 feet. Either we must suppose a direct elevation of the foundations of Aldabra, or accept Mr. Fryer's suggestion of the attraction of some comparatively recently upheaved land-mass; it is, however, difficult to see where that mass could have come into existence in Tertiary times.

I think that we must admit that Mr. Fryer has given very convincing demonstration that the lagoon of Aldabra is a secondary formation. There must have been some lagoon originally, and it seems to me that this lagoon must have been of considerable extent. I must confess I have great difficulty in seeing how the lagoon cut a channel in the first place to the sea, unless there was some channel there in the first instance. With regard to the reef washing away outside, I would join issue with Mr. Fryer as to whether it is really being washed away. If there is sand being washed over it from the land, it seems to me it is quite easy for its surface to be killed and then considerably eroded; but I did not gather that he suggested any such process. I would only express my own thanks to Mr. Fryer for a most interesting lecture, one of the most important contributions in recent years to the formation of coral reefs.

The PRESIDENT: Certainly Mr. Fryer has dealt with several geographical problems in a truly scientific spirit. His observations on mosquitoes are exceedingly important, because, if he has indicated a true conclusion, the mosquitoes which we originally thought harmless can carry disease from one person to another, and new views must be adopted of the precautions to be taken with regard to malaria in hot climates. As to the other problems he has raised, he has been discussing what may be called prehistoric geography—the question, for instance, of the probability of the existence of a bridge of land between Africa and India. The distribution of insects and of plants can throw important light on the geography of prehistoric continents, and Mr. Fryer's collections are being examined from this point of view. How the land came to rise is also a question of great interest, and his suggestion that it is due to changes in the attractive force on the sea of great mountain ranges is one which deserves further consideration. He has not only dealt with prehistoric geography, but he has also been dealing with what may be called prophetic geography—or the consideration of the future form of the islands visited. No doubt the best way to investigate this problem is the one he has adopted; that is to say, a comparison of different islands in different phases of evolution, thus indicating how one form is gradually converted into another. But that does not give one any clue as to the rapidity with which these changes are taking place; and, in order to get some estimate of rapidity, we must have accurate plans and descriptions of these various islands at different epochs. From this point of view, Mr. Fryer's paper will in future have considerable value, because he has described this island with such accuracy that a comparison of his descriptions with the then state of the island will in time give some idea of the rapidity with which these changes are taking place. I am quite sure you would wish me, in your name, to thank him, not only for the excellence of the work done, but also for the pleasant way he has described his expedition to us to-night.

Mr. J. C. F. FRYER: As regards the mosquitoes, I should mention that I only suggested that the Stegomyia could carry malaria for a certain number of generations (of the malarial parasite); it would be quite impossible to consider it as carrying on the disease for any length of time. We need, therefore, only guard against it as bridging over times when Anopheline mosquitoes are either scarce or passive.

As regards the drop in the level of the ocean, due to the formation of ice, it seems to me that this would hardly account for the facts, as we should get a slow drop, and not a comparatively rapid one, as I think is demanded in the elevation of such an island as Aldabra.

Finally, Prof. Stanley Gardiner made certain remarks about the formation of the lagoon in Aldabra. The means by which, I suppose, this has been accomplished is as follows: I showed that the rock was full of large caverns and pits,

which were all in connection with the sea. When the island was first elevated, it is reasonable to suppose that these were more numerous than they are now. The sea then, as now, therefore, could penetrate right through the island. It would at once begin dissolving the rock away, and then series of fissures could interconnect, owing to this solution. We could therefore get deep tunnels passing away into the island. The sea would naturally continue to wash the dissolved rock away until these tunnels were open to the surface. We should thus get tunnels passing into the centre of the land and increasing in size. The inner part of the island would be washed away first, owing to its low level, and would gradually become a lagoon, while the outer part, being higher, formed the land-rim.

THE FRENCH MISSION TO LAKE CHAD.*

By Captain J. TILHO.

Double Object of the French Mission.

We were assigned by our Government two distinct tasks; we had:

1. To define, in conjunction with the British Mission, the frontier between the French and British spheres, from the Niger to Lake Chad.

2. To carry out a programme of scientific researches on the country crossed by us, and especially to make a thorough study of Lake Chad and of the countries around it.

It is not our intention to speak to-night about the work of delimitation, but it is an agreeable duty for us to say how thoroughly pleasant and cordial have been our relations with all the members of the British Commission in the achievement of our common work, which went on without interruption from January, 1907, till February, 1908. The members of the British Commission were Major O'Shee, British Commissioner; Major Simonds, Lieut. Hearson, and Dr. B. M. Flood. We specially wish to pay a well-deserved tribute to the precision of the results obtained by our British colleagues, results which undoubtedly constitute a most valuable basis for African cartography. It was after having concluded the demarcation of the frontier line that the French mission commenced the study of Lake Chad, and of the neighbouring regions. We bring before you to-night the results of that work. Though the subject is rather a vast one, I will try to be as brief as possible.

When we arrived at Lake Chad an interesting and difficult geographical problem presented itself before us—

(1) Is Lake Chad gradually disappearing, or are its fluctuations subject to a fixed law?

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* Read at the Royal Geographical Society, February 21, 1910. Map, p. 380.

(2) Is Lake Chad the lowest portion of the immense plain of which it marks approximately the centre?

Our work aimed at finding an answer to those two questions. Before showing you, by a few lantern slides, the various aspects of the lake as we saw it, let me recall in a very few words, what was our knowledge of Lake Chad in the beginning of 1904. We need not speak of the first explorers of that part of Africa, from Denham and Clapperton, who discovered the lake, to Gentil, who succeeded in navigating a steamer on its waters; the names of Barth, Overweg, Vogel, Nachtigal, Monteil, Foureau, and others are too well known to you. Nor shall I recall the crushing of Rabah, rightly called "the African Attila," and the subsequent study of the Niger-Chad frontier and of the lake by the Elliot-Moll Mission.

As a result of this mission a general map of the lake was drawn up, and a hydrographic monograph of the region was published by naval Lieut. Audoin. During the first journey of Captain Tilho to Lake Chad, in 1904, the drying-up of Chad was already very apparent, and vegetation covered enormous areas of the lake. A year later, Lieut. Boyd Alexander experienced great difficulty in navigating through the central part of the lake, and when he tried to sail into the southern part he was obliged to take his boat to pieces and to carry it over by land. Six months later, a French captain, Freydenberg, crossed, half navigating and half wading, the northern portion, and penetrated well into the interior of the lake, which had become by now a great marsh.

You understand our curiosity four years after having made our first map of Lake Chad, to see what was the aspect which this constantly changing lake was likely to present. When we arrived in the vicinity of the lake, we learned from the natives that caravans were crossing on dry land the northern portion, which in 1904 we had navigated on board the *Benoit Garnier;* that the central portion was merely a marsh where no boat could pass; whereas in the southern portion certain channels, which had formerly been closed to navigation, had become once more practicable. The drying-up of the northern portion, we were told, had been so rapid, that a great quantity of fish had not had time to flee southwards, and had taken refuge in the depressions, where they had been asphyxiated in the few inches of stagnant and muddy water that had been left behind. For the natives it was quite like a new Miracle of the Fishes; they gathered them in baskets. Even to-day large areas are covered with dead fish. The herds of cattle suffered greatly from this sudden transformation of the lake. The stagnant water, saturated with salt, and charged with decomposed matter, became poisonous, and animals perished by hundreds. The rhinoceros, the hippopotamus, the elephant, themselves, disappeared southward in the wake of the retreating water.

In 1908 Lake Chad appeared to us to be divided into four different zones: (*a*) the dried-up zone; (*b*) the marshy zone; (*c*) the navigable zone; (*d*) the lagoon zone.

1. *The Dried-up Zone.*—In 1908 nearly the whole portion of Lake Chad situated north of the parallel passing by the mouth of the Komadugu-Yobe was included in this zone, whose monotonous, desolate, and funereal aspect seemed strangely at variance with that described in such bewitching colours by Nachtigal. Seen from the dunes (30 to 40 feet high) which form its western boundary, the dried-up zone presents the appearance of a vast plain extending up to the limits of the horizon, and with no sign of water on its surface.

Immediately at the foot of the dune is a woody zone, and further on a sandy plain strewed with remains of fresh-water shells, and presenting the appearance of a field of *asclepias*, where grass is rarely met with, and where by a well-marked transition one reaches the land only recently abandoned by the retreating water. The ground then becomes clay, and is covered with large crevices and immense fields of bindweeds, which the wind often rolls up in a series of huge waves. Here and there are bunches of grey reeds dried or rapidly dying. In this slightly undulated plain one meets with small depressions 3 or 6 feet deep, in which the ground is strewn with huge crevices, and the earth more recently abandoned by the waters of the lake easily gives way under the footsteps and hinders the passage of men and animals. Now and then, far from one another, one meets with wells of from 3 to 6 feet deep, containing a small quantity of grey muddy and brackish water.

Little by little the denivellations become more definite. Their summit is a little higher, covered with sand, strewn with shells, and surrounded by a barrier of fragrant bush. These are the old islands environed by better-marked and deeper depressions. Sometimes, as was the case at Kindjiria, one meets with pools not yet completely dried up, and strewn all around with thousands and thousands of dead fish.* In these islands exist thinly populated villages composed of rough huts, where live the Buduma islanders, who have now become landsmen owing to the retreat of the lake.

Farther on towards the east the depressions, always dried up, become narrower and deeper. The islands that they surround become larger and higher, presenting the appearance of dunes joined together, and extending up to the Chittati and Kanem borderlands, where dried-up lagoons wind in and out along the country. They look at first

* Dr. Gaillard, the naturalist of our expedition, brought from Lake Chad thirty-seven different kinds of fishes; three of them were recognized by Dr. Pellegrin (of the Museum d'Histoire Naturelle) as being new species, viz. the *Marcusenius Gaillardi*, the *Gephyroglanis Tilhoi*, the *Auchenoglanis occidentalis*, var. *tchadiensis*.

like dried-up rivers, then only like discontinued thalwegs, and then again like a series of well-separated and independent pools. The transition between Lake Chad and the Kanem country is hardly noticeable, and it is impossible to tell exactly where the one ends and the other begins. In all this zone, where our camels and oxen were able, from November, 1907, to July, 1908, to pass without hindrance, Captain Tilho and Naval Lieut. Audoin had in 1904 navigated without difficulty from the mouth of the Komadugu Yobe to Ngigmi, from Ngigmi to Ngollom and Kuloa, and from Kuloa to Fargimi and Debuaram. The depth of water at the time was from 2 to 4 feet, and the boat *Benoit Garnier* had a draught of 2 feet. In the islands cattle were abundant, and thrived well; in the peninsula buck was found in hundreds, while hippopotamus, rhinoceros, elephants were frequently met with.

2. The actual marshy zone of Lake Chad was in 1904 a vast expanse of open water, of from 3 to 6 feet deep on an average, with now and then at the surface tufts of grass. Navigation was easy with the *Benoit Garnier*, which had a draught of 24 inches, and on the Bornu side it was possible to anchor easily at distances of from 500 to 1600 yards from the shore. There were then but two navigable channels, "Bidellam" in the north, and "Debuaram" in the south; a third one, near Sayorum Baga, gave access for a boat to the basin of the Shari.

In 1908 things had greatly changed. We noticed it all the more that we had to wade for five days through the marsh that had taken the place of the open water in order to establish a beacon at the point 22 miles east of Bosso. Starting from Bosso, one travels for two hours, across a cultivated plain raised some 10 or 19 feet above the winding bed of the Komadugu Yobe, which was almost dry and had become, in fact, a succession of ponds, on the banks of which crocodiles were found in great numbers, and great quantities of ducks and other water-birds were fishing. Suddenly the river-bed disappears in the grass. One has then arrived at the junction of the river with Lake Chad! But no more a lake! There is not a sign of water. Everywhere are grass and reeds. In the distance a sombre mass bars the horizon like a line of hilltops. It is the forest of "*Ambach.*" You have heard of this curious tree of the tropical regions, which grows in the water and attains in two years a height of from 8 to 9 yards, with a diameter of from 12 to 15 inches. It dies when the water fails altogether, or rises above a certain level, or when it contains a too large proportion of salt. Its scientific name is *Hermininiera elaphroxylon*, its Arab name *Ambach;* the Bornuans and Kanembus call it *Fogu*, and the Buduma islanders *Marea*. When it is dry it is the lightest wood known. Its density is ten times less than that of water and two and a half less than that of cork. As you see, the impression, therefore, that one has on reaching the shores of the lake is that of entering a forest. Let us penetrate in this forest.

MARSHY REGION OF LAKE CHAD.

THE DRY REGION OF LAKE CHAD.

CAMELS AT THE WELLS OF ALI-AGRENGHA.

BORNU WOMAN.

The muddy and opaque water in which it lives conceals gullies that are deep enough and broad enough to provoke the most comical falls. Progress is slow; not more than a mile an hour, for it is often necessary to cut one's way through, as the aquatic bush is very thick. After a few miles, the traveller leaves the marsh and arrives on a low waterless plateau of black clay, which is full of gullies. On these plateaus one might think that fresh water is easily obtainable on digging the soil. It is not so generally. We have dug wells 3½ yards deep without reaching water. When the plateau is crossed the marsh begins again. Then one finds another plateau, and so on. Apart from the ambach, the vegetation of this part of Chad consists principally of high reeds and papyrus. As to its inhabitants, I think the mosquito is the most important, the liveliest, and the cruellest! The marshy zone covers about a third of Chad.

3. Let us now study briefly the *navigable zone*. It has undergone important modifications. The average depth has changed but little, but the vegetation has developed almost incredibly, reducing the navigable portions to a small number of channels. The only means of communication by water, when we were at Lake Chad, between the coast of Bornu and that of Kanem or the mouth of the Shari, started from Sayorum Baga, 27 miles to the north-east of Kukawa, the old capital of Bornu. One has to punt at first across an expanse of open water covering an area of from 16,000 to 20,000 acres, bounded on the north, south, and east by impenetrable forests of ambach. Then one enters a narrow channel about 2 miles long, which has been cut through the forest, and which leads into open water resembling more a large river than a lake, with thickly wooded banks. Following this river, one meets with waterways, most often leading towards the centre of the forest. As a matter of fact, only two or three of these waterways lead towards Kanem, or the mouth of the Shari. The landscape is unchanging in its interminable monotony, and it is impossible to see anything else in any direction but the impenetrable barrier of thick and high vegetation. There are no birds, no animals of any sort, apart from mosquitoes and fishes. Now and then a band of Budumas pass slowly in their heavy straw canoes transporting dry fish, *natron*, or cattle which they barter at Bornu for millet, cloth-stuffs, salt, pottery, etc.; and when the canoe has passed, the oppressive silence of this dead or sleeping Nature returns, troubled solely by the noise of the big fish leaping in the water. The edges of the ambach forests gradually widen out, and after long hours of slow navigation, one enters at last into a large expanse of open water encircling the mouth of the Shari, and covering an area about the size of, I should say, London and its suburbs. This forms only about the fiftieth part of Lake Chad, and it is all that remains of the original aspect of the lake. The rest is merely marsh, lagoon, or dry land. Depths of 12 feet are rare. The

average depth is from 6 to 8 feet. East of the mouth of the Shari the depth diminishes rapidly, and the limit of the navigable zone at that point is marked by the meridian of Hajer-el-Hamis.

4. There is also a *Zone of Lagoons in Chad.* It is situated all along the coast opposite to that where the tributaries run. The shore is cut by a multitude of lagoon-channels of varying depth and breadth, intersecting one another in all directions, and penetrating into the interior by narrow closed lagoons which wind, like dead rivers, and end in chains of ponds or in independent basins. When Lake Chad was full of water this system of lagoons began at N'guigmi and continued uninterruptedly along the Kanem coast up to the mouth of the Bahr-el-Ghazal. At that period, 1908, the entire portion between N'guigmi and Kindin followed the movement of the northern portion and dried up. The southern portion alone still preserved the character which had been observed in 1904.

The intersection of these numerous channels has, naturally, created a quantity of islands, which form the archipelago of Lake Chad, and which may be divided up into four classes: (1) *the cultivated islands* near the Kanem coast, which are from 35 to 50 feet above the lake, and are virtually dunes covered with the familiar Sudano-Saharan steppe and savanna vegetation, while the Egyptian palm is now and then to be seen at the base of the dune, behind a girdle of reeds; (2) *the inhabited islands*, somewhat less elevated (15 to 25 feet), further from the coast, with little flora save the pale-leaved *asclepias*. These islands afford shelter to the Budumas against the attacks of the Tedas, Oulad Sliman and the Wadaian bands; (3) *the pasture-land islands*, still less elevated than the preceding, and still further from the coast, and utilized by the magnificent herds of the islanders; (4) *the islands in formation*, or banks: it is ground that has temporarily emerged, and is generally to be found at the edge of the lake forest lying between the zone of the lagoons and the navigable zone. Submerged from November to April, they serve for the rest of the year as anchoring points for the native fishermen. There are but three channels permitting a boat to quit the zone of the lagoons: (1) Samia-Sayorum-Baga; (2) Samia-Shari; (3) Bol-Shari.

The Budumas.—We must now deal with the inhabitants of Lake Chad, those dreaded islanders whose daring flotillas spread terror along the Bornu and Kanem coasts. The word Buduma means "reed-dweller," but they call themselves Yedinas, a name which recalls that of *Yedi*, by which the Kanembus indicate the region of Bahr-el-Ghazal. The Budumas of the south-east of the lake are particularly known as Kuris, and are somewhat different from those of the north. The Kuris are for the most part an agricultural people, who cultivate successfully the fertile low-lying soil temporarily abandoned by the lake. They willingly mingle with the inhabitants of the lake-shore, and in this

particular resemble the Kanembus. The Budumas of the north-east, on the contrary, are more warlike. They are herdsmen who do little farming, and live on milk and fish. Intermarriage within a single tribe is common among them, a fact both weakening and refining the race. Their customs are virtually those of the negro tribes of the centre of Africa, who are partly converted to Islamism.

They have a legend to the effect that a Kanembu, by the name of Bulu, had an elder brother who shortly after his marriage went on a pilgrimage to Mecca. Three years later, since he had not returned, Bulu, believing him dead, married his sister-in-law. She was about to become a mother when the return of her husband was announced. Rather ashamed and afraid, Bulu fled to the lake. He lived in hiding, on fish, at Taguel, near Samia, when one day the strong wind blowing from the west brought to him a large calabash containing millet. Surprised and delighted, he concluded that the western shore of Lake Chad must be inhabited by cultivators, and he decided to visit them. He utilized the *calabash* as a boat, and made his way thus as far as Kawa. There he went ashore, was captured by the reigning tribe, the *Sos*, and taken to the chief, to whom he related his adventure. This chief treated him well. But Bulu, incorrigible, having made love to his daughter, called Sado Saorom, the chief was, according to the laws of his tribe, obliged to give him his daughter in marriage. He did so, and ordered him to return to Lake Chad with his wife in order to conceal their fault. Upon his return to Taguel, Bulu set out for Kanem, with the intention of asking his brother for his share of the cattle of the paternal heritage. But at the last moment, not daring to appear in person before his brother, one fine night he carried off the entire herd, and hastily rejoined his wife at Taguel. The brother pursued him, and came upon him in his island, thinking he had overtaken some ordinary robber. All his resentment disappeared at the joy of seeing again his younger brother, and at the surprise of finding him married to a woman of an unknown race; he asked him to go back to Kanem with him. Bulu, however, refused, and the herd having been divided up, he remained alone in his island with his wife, where they became the ancestors of the Budumas. The children learned their mother's language, and that is why the Budumas' language is so much like that of the Kotokos, who are the descendants of the Sos. All that happened at some vague period between the ninth and the fifteenth centuries.

Since then the Budumas, defended by their lagoons, have lived independently in their islands. Rabah himself could not injure them. Their audacious robberies gave them the reputation of being terrible warriors, and alone the white men, "with their boat which travels swiftly and their far-shooting rifles," as they say, could worst them and suppress their pirate expeditions. They actually number about

45,000. To-day peace reigns all about those shores and throughout the archipelago.

From a general point, Lake Chad is a vast closed depression of slight depth, entirely independent of the great tributaries of either the Atlantic or the Mediterranean. It occupies an area of about 10,000 square miles, that is to say four-fifths of Belgium. Its average depth is 5 feet, and no lake in the world is so shallow. Its shores are very undefined, for the slope is so gentle that very slight variations in the level of the liquid expanse are sufficient to cause the submersion and emersion of vast tracts of soil. Even the wind is sufficient to do it on the southern and western banks. It can provoke within a single day a movement so important that certain travellers have maintained that the lake was subject to tidal phenomena.

The waters of the lake are renewed (1) by atmospheric precipitation for about a tenth part; (2) by the contributions due to its affluents for about nine-tenths. Those affluents are: *the Shari*, which in 1908 brought to it about 40 milliards of cubic metres of water (about one-ninth of the Danube), but which has of late years fallen off; *the Komadugu Yubé* (130 millions cubic metres); *the watercourses of German Bornu*, too dry during our visit to permit of any calculations. It is a special characteristic of these affluents which run from the equatorial or tropical regions towards the desert that they diminish in volume as they get further from their source, and that they contain any considerable amount of water only at certain months in the year.

The losses of Lake Chad are due to *evaporation* and *infiltration*, evaporation being particularly intense just at the epoch of the year when the tributaries have the least volume of water. In 1908 it measured 6 feet. The loss by infiltration we were unable to calculate. The variations in the extent and level of the lake surface are consequently entirely due to meteorological causes, and it is impossible in the present state of the science of meteorology, as applied to the climatological conditions in Central Africa, to formulate a law governing the rise and fall of this sheet of water. There is, however, no reason to suppose that the lake is likely to disappear. It will remain for a long time still in the centre of Africa, now dilated, now contracted, and in general offering unfavourable conditions for navigation, so it will always constitute rather a barrier than a bond of union for the inhabitants of its shores.

The Chad Low Region.

Let us now deal with the second portion of our geographical problem. Is Lake Chad the lowest point of the immense plain of which it is approximately the centre?

BORNU GIRL.

BUDUMA CANOE ON LAKE CHAD, NEAR BOL.

BUDUMA VILLAGE.

BUDUMAS FISHING.

In the south and west the course of the affluents to which I have referred (the Shari, the Komadugu, etc.) is sufficiently indicative of the direction of the slopes. But in the northern and eastern regions the absence of visible tributaries of the lake left much doubt, and gave rise to various hypotheses. We confided the investigation of this interesting question to two reconnoitring forces. The first was ordered to proceed up to the boundary of the Borku country. The second was directed to study particularly the region of the Bahr-el-Ghazal and of Lake Fittri. Both these regions are desert, and are often traversed by Senoussi incursions from Borku and the country north of Wadai. These bandits, who are brave and well armed, are notoriously cruel. They fight the sedentary and the nomad tribes placed under our protection in order to take their cattle, and above all to obtain slaves for export to the Mediterranean coast and the vilayet of Tripoli. Their chief headquarters is Ain Galaka in Borku. They are well commanded, not very numerous, but very enterprising, and give a good deal of trouble to our Kanem Meharists, who, to the small number of fifty, keep in order as well as they can this immense region, which is half the size of France.

To give an idea of the daring and ferocity of this enemy, and of the rapidity with which news travels in the desert, we shall relate an incident which occurred during the reconnaissance under the command of naval Lieut. Audoin. When he was in camp at the Guradi (Gossom) well on May 22, 1908, a friendly Teda, who had followed the detachments by our trail, brought the news that five days before a razzia from Galaka had carried off at Bir Daudi a part of the smala of the friendly Arabs and Tubus, and that all the auxiliaries of the post of Ziguei had been immediately sent in pursuit. Two of the Arab guides who accompanied the Audoin detachment heard that their wives and children had been captured. They requested to be allowed to leave the column in order to pursue the robbers.

On May 29, at the well of So-Yamussa (Toro) on the return journey from Koru, three Tadas brought us the news that the razzia, comprising eighty Khoans, had been within one day's march of the Audoin column, and had been attacked by the Ziguei auxiliaries at Ekinde, where an indecisive engagement had taken place.

On June 10, at the well of Ali Agrengha, an Arab from Ziguei brought fresh details as to the fighting at Ekinde. The auxiliaries had been surrounded by the Khoans, but some of them succeeded in escaping, among them our informant. Four others, however, were captured, including the two Arab guides who had left the column at Gouradi, and whose wives and children were prisoners. The man added that, fearing to be accused of being a coward, he had returned two days later to the well of Ekinde. The Khoans had there abandoned their prisoners, after having cut off their feet, broken their fingers, and placed them

alive on a fire made of camel offal. The poor devils were still alive, and had had the strength to drag themselves a few feet away from the fire towards the well. That is the kind of bandit with whom our Meharists have to deal.

Let me now give a brief idea of the aspect of the regions traversed by these two detachments.

(1) *Kanem.*—Kanem and the regions which depend upon it geographically (Chitati, Lilloa, Manga) constitute a plain, the level of which, according to our observations, is sensibly the same as that of the lake. But this plain is covered by a layer of sand, which thickens as one leaves the lake and attains its maximum (70 to 75 yards) in the vicinity of Mao and Ziguei. The sands have the form of a succession of waves moving from north-north-west to south-south-east in the hollows of which are wadis, a kind of dune valley, which resemble the depressions of the borders of Chad. So that the whole of the Kanem region was obviously an old archipelago of a larger Chad.

(2) *Bahr-el-Ghazal.*—To the south-east of Chad extends a plain of black and broken clay covered with a fairly dense vegetation, in which Egyptian palms dominate. It is the plain of the Bahr-el-Ghazal, where, amidst the low and often ill-defined islands, is distinguishable an unbroken ridge, sown with *débris* of shells and covered with Asclepias, and about 100 to 500 yards broad. According to our observations the Bahr-el-Ghazal presents none of the characters of a valley, but recalls rather the dried-up lagoon zone of Chad, but a lagoon in which the invasion of the sand began a very long time ago. The subterranean liquid expanse is now very near the surface, now at a depth of from 15 to 16 yards. According to our measures its level is that of Lake Chad. We were unable, owing to lack of time, to explore the Bahr-el-Ghazal beyond Fantrassu. North of that point up to Kuri-Torao and Jérab methodical investigations remain still to be accomplished.

(3) *Lake Fittri.*—Fittri is a closed lake, fed solely by the local rains, of a slight depth (5 to 6 feet) with the area of Paris when the water is low, and with an expanse four times as great when the water is high. Although there are no outlets the lake is not saline, in which respect it is, with the Chad, an exception to the general rule. According to our observations it is 50 feet above Lake Chad. The inhabitants of the Fittri region are sedentary Bulalas, chiefly occupied in the cultivation of millet and cotton.

(4) *Eguei.*—It is impossible to call Eguei a valley or even a depression. At no moment has the traveller the impression of "descending" into Eguei. Seen from the plain which borders it on the south, the Shilim Fahalanga, or from that which borders it on the north, the Moji, the Eguei region has a chaotic aspect, in which the fixed or moving dunes, of from 60 to 100 feet in altitude, are mixed in inextricable

confusion. Another peculiarity of the plain of Eguei is the proximity of the subterranean water. In certain points the antelopes have only to scratch the soil with their feet to obtain drinking-water. The average level of this water is 6 feet lower than that of the liquid expanse of Chad. It is not impossible that the two expanses were formerly in superficial communication, and even that they communicate still below the surface. The remains of the lake fauna, the vertebræ of the fish, and the shells gathered in the Eguei region are identical with those found in Lake Chad. The well water in the Eguei region has certain curative properties which are appreciated by the camels in the neighbourhood. They are brought thither annually for a three or four weeks' cure.

(5) *Toro and Koru.*—After three days' march in the denuded, often rocky, and absolutely waterless region that extends to the north-east of Eguei which the Tedas call Moji, one arrives in the Toro region, where the water is at the surface of the soil. This region communicates by the Jerab with the Bahr-el-Ghazal. The Toro is even less than the Eguei a valley or depression. It is an inextricable mixture of mobile dunes running from east to west. To cross this sand-waste one requires a foot as expert as that of the camel. The water of Toro, which is still more curative than that of the Eguei, is, according to our calculation, 195 feet below the level of that of Chad.

A stage to the north-east, at the limit of the Borku territory, is Koru, a chaotic plain resembling Toro, where water can be found at a depth of from 3 to 6 feet. Its altitude is 480 feet, according to our calculation—that is to say, 203 feet below that of the level of Chad.

The general result of our observations goes to show that to the north-east of Chad there is a series of low plains, whose altitude is considerably inferior to that of the lake. The country drops off at about 205 feet in less than 250 miles. Lake Chad is not, therefore, the lowest point of the immense plain of which it occupies approximately the centre. This plain falls from the west to the east at a uniform rate of about 1 in 5000. Must we conclude that the Lake Chad low regions have received the overflow of the lake at the epoch when the Sahara was more moist than at present? That is not impossible, but it cannot be proved by mere considerations of difference of altitude.

It would have been highly interesting to continue our researches in order to determine the lowest point of this immense plain, which holds in the pockets of its gentle declivities the waters of the Chad, the Eguei, and the Toro, and to verify the affirmations of the old geographers as to the presence there formerly of a branch of the Nile. But the instructions we had received from our Government did not allow us to cross the boundaries of the Borku region. We were obliged to return,

and to leave, we hope, to the future the joy of surprising the secret of these hundreds of miles of unknown country, the mysterious attraction of which is so powerful.

The Return by Northern and Southern Nigeria.

When we had finished our studies of the Chad region, there arose the question of our return. The journey was accomplished in two groups. The more important, under the orders of Lieut. Audoin, took the desert route along the southern edge of the Sahara. It was to continue to take along that route the same scientific observations which had been made along the frontier-line. The other group, of which Captain Tilho took the command, went through Kamerun (*viâ* Dikoa) and Nigeria, which the British authorities had graciously allowed us to cross, and which was the shortest route. We went *viâ* Kano, Zunguru, Ilorin and Lagos. Everything we saw from Lake Chad to Zungeru shows the methodical and practical way, the intelligence, the energy, the strong will of the men who have undertaken the task of civilizing and improving all that part of the British Empire.

We met the Governor of German Togo, Count Zech, on the Niger. He was coming to study the administrative methods which have given such good results to the British in both Nigerias. He dined with us on the evening of his arrival, and so did our sympathetic British comrade Captain Kempthorn. We cannot help recalling the vision of that gathering around a French table under the African sky, and by the British Niger, of the representatives of those three nations who are responsible for that part of the world through which we had travelled. Those nations are no doubt perfectly united in the spirit of the constant necessity of co-operating in colonial matters; they have made themselves the guardians of these African populations. The noise of the discussions they might indulge in in Europe ought never to reach Africa; their administrative methods ought to be as far as possible on the same lines on both sides of the colonial frontiers; it would certainly be the best means, under different flags and with different languages, of achieving the triumph of order and peace against anarchy and insecurity which, till recently, have impoverished Africa and made its population so miserable. All the Africans support that "colonial entente," because they know how useful it would be. We may be allowed to say that all those friendly delimitations of colonial frontiers which have been made in recent years, prepare the way to a more complete understanding between the interested nations in Central and Equatorial Africa. The co-operation of the administrations of the different colonies would be the most powerful means, and most probably the only one, to utterly destroy the scourge of slavery in Central Africa.

CHIEFS ON ISLAND OF LAKE CHAD.

IN THE MARSHES AT ROSEAUX.

VILLAGE IN THE DRY REGION OF LAKE CHAD.

DRY VEGETATION ROLLED BY THE WIND.

During our journey across Nigeria, we heard several times some people expressing the idea that if the slave trade was still flourishing around Lake Chad the fault was chiefly due to the Germans and to the French, because they did not repress the evil with sufficient energy. I think it is our duty to be very clear on that point: we can repudiate such supposition as far as France is concerned, and no doubt Germany may do the same. Everywhere, where civil or military administration has been established by France, the slave trade has completely disappeared. At present it exists only in the countries which have till now escaped the action of the French as well as of the English, in the proximity of the frontier-line, which divides the regions of the Chad from the regions of the Nile, on 1500 miles of country. Last year the French occupation of Wadai was a great step towards the suppression of the slave trade, and since then the caravans carrying slaves have abandoned the route of Abeshr, probably to take another route more to the east. It is specially upon England and France that devolves the duty of achieving the suppression of slavery in those regions which lie in their zone of protection. But to obtain that result two paramount conditions are absolutely necessary:—

1. A thorough co-operation in the means of working towards that aim, between England and France, and also Germany.

2. To proceed, as soon as it will be possible, to the effective occupation of the respective British and French territory lying between Lake Chad and the Nile.

It is a great task which civilization imposes upon England and France in that part of the world. I do not think it is too much to say that our honour, as civilized countries, is at stake in it.

Three days after leaving the Niger we arrived at Ilorin, where we took the English railway for Ibadan. We met there with the most courteous reception from the Governor of Southern Nigeria, Sir Walter Egerton, and from Lady Egerton. We arrived at Lagos on August 12, after ten hours of railway across a country showing marks of the most evident prosperity.

We had an identical general impression during our goings and comings in Northern Nigeria and Southern Nigeria, that they are regions rich in resources, inhabited by a relatively numerous, active and intelligent people, and generally law-abiding; they are governed by officials who know their business perfectly, and who are sincerely interested in their work. I think Great Britain may justly be proud of the work she has done and is doing in this portion of Africa, work which we have most sincerely and greatly admired.

I cannot close this lecture without addressing to the Government of H.M. the King, the expression of our deep gratitude for the kind way in which we were accredited to the British representatives in Nigeria. I wish also to express our gratitude to the Royal Geographical Society

of London for the honour they have done Captain Tilho and his Mission in allowing us to bring before this distinguished audience the results of our studies on Lake Chad and the country east and north of the lake.

NOTES.

1. *Vegetation.*—One might ask why it is that vegetation is so scarce and miserable all around that part of Lake Chad where the heat is great and water abundant. The cause will be found in the very slight hygrometrical condition of the atmosphere save during the four annual months of the rainy season. The annual rainfall likewise is very small, 5 inches (mean); 7½ inches in 1908, which year was considered as very wet. One must not forget, also, that the northern shore of Lake Chad is that of the desert, while the other shores belong to the Sudan region.

2. *Alluvia—Organic Deposits.*—The different tributaries of Lake Chad deposit alluvia on all the surface of the lake; these deposits, together with those due to decomposition of aquatic plants and to the supplies brought by the winds, contribute to the heightening of the bottom of the lake, and add to the other causes determining the instability of the level of its waters. Part of these alluvia are deposited near the mouth of the various tributaries, thus forming *cônes de déjection* standing out for a few hundred yards only. These *cônes de déjection* once crossed, nothing reveals the presence of a river-bed in the near proximity, and coming from the lake one can easily pass before the mouth of one of the Chad tributaries without noticing its presence.

3. *Depth—Annual Flood.*—As is well known, one calls—

(i.) Mean depth of a lake the relation between its volume and its surface;

(ii.) The hollow of a lake, the relation between its volume and the square root of its surface.

The mean depth of Chad is insignificant; 5 feet or thereabouts in the navigable zone; 7 to 9 feet in the lagoon zone. The maximum depths observed by Naval Lieut. Audoin in 1903 are: 20 feet between Madiorou and Karinda, and 13 feet between Wanda, Kann, and Iba. These depths are exceptional.

The immerged outline of Lake Chad differs totally from the theoretical outline of our European lakes. However, if one tries to estimate the hollow of the great Central African lake in order to compare it with the hollow of certain well-known lakes, it will be noticed that it is incomparably smaller than that of any of them.

The hollow of Lake Chad equals approximately 1:24,000; that of Lake Peypus (Russia), which is considered as extraordinarily small, equals 1:4420.

The highest level of the water is reached in Lake Chad in December, and the lowest level in August. The difference between those two levels in 1908 was 31½ inches.

4. *Proportion of Salt.**—Nachtigal has written that the waters of Lake Chad are fresh. From this statement it has been concluded that the lake must have an issue somewhere, and the hypothesis of the Bahr-el-Gazal being an "effluent" of Chad

* The analysis of the different samples of water taken by us in the different zones of Lake Chad is not yet completed. It is being done at Copenhague, by Dr John Schmidt (Commissioner for Havundergelser Afdeling Fiskeri).

seemed to give to that conclusion a tempting appearance of probability. Our reckonings have shown that the Bahr-el-Gazal, situated on the same level as the lake, could not be considered as its "effluent."

On the other hand, the water of Lake Chad is really fresh only at the mouth of its tributaries; its proportion of salt becomes more and more noticeable as one goes farther from the mouth of those rivers. In the lagoons the water is sometimes so full of salt and impurities that it is absolutely useless.

5. *Signal-marks—Anomalies.*—Owing to lack of proper means, we were unable, in 1904, to place in different parts of the lake the sign-posts which would have been necessary to assure the precision of the comparisons that were to be effected afterwards. Hence we were only able, in 1908, to estimate approximately the difference in the level of the lake in 1904 and 1908 through comparing the results of the soundings effected during those two years at the same points. The fall was evident in northern Chad, and we estimate it to be $3\frac{1}{2}$ to 4 feet. In southern Chad the fall was much less obvious, and cannot in any case be above 12 to 16 inches.

In order to be able to appreciate exactly the future fluctuations of the level of the Chad, we placed in the lake (and in the best positions of stability possible) two hydrometrical sign-posts, one at *Bol*, the other at *Kouloa*. Two other iron sign-posts, of the same model as the first, were placed so as to mark the position of the frontier, one in Binger island (northern Chad), the other in Sayorum Fallières island (southern Chad).

In certain "bahrs" or lagoons of southern Chad which were dried up in 1904, we found in 1908 that the water was again rising; for instance, north of Bol, west of Kanassarom, and regions of Koukia, Materam, N'Guirom. In other places we found an increase of depth of water; for instance, between Bol and Berim, north of Tindal, between Bol and Kanassarom, between Kanassarom and Goudji, and between Mishilela, Tatavirom, and Kelbou.

These facts, which at first sight appear anomalous, because of the general drying up of the lake, may be explained either by the increase of depth in certain "bahrs" (caused by currents), or by the increased height of the central part of Chad under the influence of alluvia and organic supplies; this increased height rendering all means of communication between southern and northern Chad most irregular.

6. *Climatology.*—The natives divide the year into three different seasons succeeding each other very quickly—

(i.) The cold season (November to February).

(ii.) The hot season (March to June).

(iii.) The rainy season (July to October).

Cold season. Our observations give 34·5° to 37° Fahr. as absolute minima for January and February, 1908. The wet thermometer of the psychrometer fell to 29·5° Fahr. on February 16, 1908. The maxima during these two months were 99·5° Fahr. January 5, and 100·2° Fahr. February 21. During this season the atmospheric moisture was very slight, and the dominant winds blew from the north-east and east-north-east.

Hot season. Our observations give: absolute minimum 57 Fahr., March 5; absolute maximum 113·2° Fahr., March 20. The temperature marks a considerable rise, its variation in one day reaching sometimes 45° Fahr. The hygrometrical state of the atmosphere increases; the winds are less regular and have a tendency to blow from the south; several tornadoes, generally dry, appear in May and June. Decomposition of organic matters becomes very active in the waters of Chad under the high temperature, and the quality of these waters may be very much influenced.

Rainy season. Our observations give: absolute minimum 70·2° Fahr., September; absolute maximum 104·4° Fahr., September. The temperature is slightly less high than in the previous season, but as the hygrometrical state of the atmosphere rises steadily, reaching its maximum in August, it is much more painful to bear. The winds blow very irregularly from the south-west. They are very strong only during the tornadoes, and they then blow from different quarters. Well-characterized tornadoes run generally from east to west, and very rarely from west to east. The following are the results of rainfall observations at our meteorological station of Chad (Bol):

July	6 days' rain;	rainfall	32mm·1 or 1·3
August	11 „	: „	134mm·3 „ 5·4
September	4 „	: „	21mm·7 „ 0·9
October	2 „	: „	4mm·3 „ 0·2
November	no rain		
December	„		
Total for 1908 ...		...	192mm 4 or 7·8

The year 1908 was considered as very rainy; we estimate that two-thirds of the rainfall of that year (5·2 inches) would be approximately the mean of the annual rainfall on Lake Chad.

7. *Note on the Determination of Altitudes.*—Our altitude reckonings in the country east of Lake Chad were based on the simultaneity of observation of the atmospherical pressure between the meteorological station of Chad and other points whose altitude was to be determined. Every precaution was taken to suppress errors due to the instruments. But it is well known that the formula of Laplace becomes of less certain application when the distance between the stations increases. The Eguei country being approximately 190 miles from Bol, we estimate that 33 feet (corresponding to a total error of 1 mm. of pressure) will represent the possible uncertainty in one sense or the other, in the results we have obtained.

8. In the *Bulletin du Muséum d'Historie Naturelle*, 1909, No. 6, p. 375, Mr. L. Germain says that the Tilho mission brought back a great deal of material for scientific study, amongst which that coming from Eguei offers special interest, as it fills up a gap in our knowledge, and gives us a fresh proof of the uniformity of the fauna throughout the regions included between the Nile and the Senegal.

The PRESIDENT (before the paper): We have come here to-night to enjoy what I think may be fairly described as a peaceful invasion of the French army, the French forces being under the command of our distinguished guest, Captain Tilho. In 1907, a party of French officers and men under the same commander met in Africa a party of English soldiers, their object being (our ancestors would hardly believe it) not to fight, but to settle in a peaceful way certain questions concerning a boundary, and I am delighted to say that those labours have been brought to a perfectly harmonious conclusion, the final act concerning this mission having been signed this very day. Nothing could be more satisfactory. Captain Tilho on that mission was accompanied by several colleagues, by Lieut. Mercadier, by Dr. Gaillard, and by Captain Lauzanne. After the conclusion of his labours as regards the boundary, the French Government very wisely, if I may venture to say so, deputed him to undertake a careful scientific examination of Lake Chad and all the region lying to the north-east of it. I am not going to anticipate what he will tell us about that mission. One remark, however, I must make, because I am sure he would not make

it himself, and that is, as regards our detailed knowledge of Lake Chad, we are far more indebted to French officers for our existing information than to any other body of men. Of these explorers Captain Tilho and Captain Audoin no doubt stand out as pre-eminent. Captain Tilho was no doubt selected for this his second expedition to Lake Chad because he was well acquainted with that part of the world, and also because of his distinguished career in the French army. He had seen service both in Madagascar and West Africa. He is a good English scholar, but being a little troubled with modesty, he has asked his colleague, Lieut. Mercadier, also an officer with a distinguished career, to kindly read the paper for him.

The PRESIDENT (after the paper): In my preliminary remarks I said that these two officers were eminently qualified to speak on questions connected with native administration, and that makes their concluding remarks, in which they have expressed the appreciation of the British administration in Africa, very pleasant for us to hear. Lieut. Mercadier has come, as I believe, all the way from active service in Algeria in order to read this paper here to-night. Captain Tilho and his comrades have come here from a distance to tell us of their interesting travels, and I should like to tell them, as I am certain I may in the name of every English man and every English woman here, that we regard their presence to-night as an International compliment which we much appreciate. Such meetings, where we have French officers describing their friendly relations with English officers, augur well for the happy relationships between the two countries, whether it be in Europe, where we are separated by a stormy channel, or whether it be in Africa, where we seem to be separated merely by an invisible line and a few telegraph poles.

H. E. M. CAMBON (French Ambassador): I thank the Royal Geographical Society for the reception given by it to Captain Tilho and the officers of the French Mission for the settlement of the boundaries of Nigeria.

In the lecture just delivered, you take note of Captain Tilho's reference to the good relations which have uniformly subsisted between the English and the French officers of the Boundary Commission. They have acted together on a footing of perfect friendliness, and their labours have been pursued without any friction. They have been inspired with the sentiments of sincere goodwill animating the two Governments and the two nations. In Equatorial Africa we have both a task which imposes on us great responsibilities, and may be full of dangers. Only on condition of standing closely united with each other shall we successfully accomplish our mission. Thanks to our union, we shall be able to maintain peace in regions hitherto abandoned to lawlessness, insecurity, and the nefarious deeds of slave dealers; we shall show once more how France and England are ministers of progress in the world, and that the *Entente Cordiale* is destined to become an instrument of civilization.

Major O'SHEE expressed his admiration of the French work and administration in Africa.

Mr. P. A. TALBOT: May I first venture to congratulate Captain Tilho on his most interesting paper, and the lecturer on his extraordinary command of our language? As one who has spent an exciting, never-to-be-forgotten, and most hungry time on Lake Chad in 1904, I should like to make a few remarks, and should be grateful to have the opportunity of asking one or two questions. The fall of the lake must, indeed, have been very rapid in 1904–5, since, as we have heard, at the beginning of 1904 navigation was easy with the Benoit-Garnier of a draught of 24 inches, while at the end of that year we had difficulty with a boat of only 9 inches draught. There is a tradition among the Borgu who live in the

north-east part of Nigeria, that a long time ago the upper bend of the Niger did not flow in its present course, but turned to the east. Now if there is any truth in that tradition, the probable course of the river might have been by Lake Chad and the Bahr el Ghazal or the Eguei to the Nile. That would harmonize the traditions both of the Borgu and of the ancient geographers of Europe and Egypt, and our old friend Herodotus would turn out to be right once more. The tradition would also account for the presence of Nilotic fish in the lake: I believe the proportion is thought to be about 40 per cent. Nilotic to 60 per cent. Nigerian. May I ask by what method the differences of height were obtained round Lake Chad, whether by triangulation or levelling, or in what other manner? There has been considerable discussion lately as to the presence of flying fish in the lake. The first specimen of this variety was caught farther to the south by M. Jean de Brazza in a butterfly-net, as it skimmed over the surface of the water. I happened to see one myself, but additional testimony is wanted, and perhaps Captain Tilho or one of his companions could supply the deficiency. I should also like to express my appreciation of the heroic endurance necessary for star-work in this locality, as I can personally testify to the remarkable biting propensities of the local mosquitoes. With regard to the slave trade, may I say that it seems to me impossible for any nation, with the resources at its disposal, to have done more than our neighbours across the Channel have done for the last fifteen or twenty years to bring the regions of Northern and Central Africa into a state of law and order. Every geographer must have watched with interest and admiration the steady and indomitable advance in the formation of that vast empire which now acknowledges French sway there. Those who know how long it has taken to overcome a few of the difficulties which confronted ourselves in Northern and Southern Nigeria can appreciate, perhaps better than others, the immensity of the task which faced the great nation with whom we are happily on such friendly terms. In conclusion, although one of the most junior officials in Southern Nigeria, may I beg to thank Captain Tilho and the lecturer for their very kind remarks with regard to the British Administrators of the two colonies.

The PRESIDENT: Unless there is any one else who wishes to take part in this discussion I think I will bring it to a close. I will express, as I know I may, your cordial thanks to Lieut. Mercadier for the charming way in which he has read this lecture in our language, for all his comrades for having come here, and, above all, to Captain Tilho for the interesting geographical paper, containing so much valuable knowledge, which he has given us.

Captain TILHO briefly expressed his warm thanks to the meeting and to the Society for the way in which he and his comrades had been received.

THE MONGOLIA-SZE-CHUAN EXPEDITION OF THE IMPERIAL RUSSIAN GEOGRAPHICAL SOCIETY.*

By Colonel P. K. KOZLOFF.

By the exploration of Mongolia and the Koko-nor province the expedition accomplished two-thirds of the task imposed on it by the Geographical Society. There remained the last third, the last period of its activity, the Sze-chuan section, for which the expedition made

* For narrative of the first portion of the expedition, see *Geographical Journal* for October, 1909. Map, p. 380.

ready in the pleasant oasis Hui-tê, situated on the right bank of the impetuous Hwang Ho, in a large and warm valley.

Hui-tê has partly an urban population—officials, merchants, tradesmen—settled about, within or without, clay walls, which enclose very small areas close to the Hwang Ho, and is partly inhabited by agriculturists in widely scattered farms, chiefly up and down the course of the Yellow river. Hui-tê is famous for its garden cultivation. Hui-tê pears find a ready sale in the neighbouring markets of Hsi-ning and Kumbum.

In connection with the adjacent highlands, with their numerous cattle-breeding nomads, Hui-tê plays an important part as a market for the exchange of commodities. Hither the nomads bring raw materials and drive their cattle, receiving in return grain or parched meal (*tsamba*), tea, utensils for domestic use, and their peculiar ornaments. The shrewd Chinese merchants deal profitably in the local spirits, of which the nomads are very fond. In Hui-tê, as in Donger, the nomads feel quite at home, and here, too, their pride, haughtiness, and warlike appearance inspire the meek Chinese with fear and respect.

The weather during our sojourn of three months in Hui-tê was in general good, especially in the autumn months, October and November, when mild, sunny days were the rule. December was generally cloudy, and east or north-east winds brought frost and also dry weather, and thin snow covered the valley for a time. The finest dust of loess fell on the ground whenever it was bare.

Having adapted the building of the temple for habitation, we settled ourselves comfortably in it, and, having constant occupation, did not notice how the time passed. My comrades made frequent excursions into the mountains or in the valley, while I, in November, paid a visit to the monastery Choibzen-khit, lying to the north of Hsi-ning, and stayed there long enough to thoroughly examine its interesting temple, and learn to know the principal Choibzen incarnation. He was an old acquaintance I had met during the expedition of Prjevalsky, and he gave me a hearty welcome, and allowed me to take some photographs of him.

After considering from all sides the future action of the expedition in its last period, I came to the conclusion to leave our winter quarters, not in March, as I had before intended, but in the middle of January (1909), and proceed, not to Sung-pan-tin far off to the south-east, but to the monastery Rarcha-gomba, situated in a south-westerly direction, and much nearer than Sung-pan-tin, and in spring to return to Alasha-yamin, and to arrive at Khara-khoto before the hot weather. This plan was carried out in its main lines, but was modified in some particulars. Owing to the difficulty of hiring carts in Amdo, and for other more important reasons, the monastery Rarcha-gomba was left a little on one side. On account of these carts, too, the expedition left Hui-tê

not in one, but in two detachments. The heavy baggage, which would have delayed our progress, was sent off by the nearest road to the monastery Labrang, in charge of my comrade Captain Napalkof, who had with him two men of the escort, the taxidermist Teleshof and the interpreter Madaief. P. Y. Napalkof went about his own work after reaching Labrang and storing the baggage there, proceeding to the town Wei-yüan Hsien, and devoting himself to geographical and zoological work in its environs. For my part, I decided to go to the bend of the Yellow river, with the object of studying the character of the Amdo highlands, the manners and customs of the inhabitants, etc.

In its general character Amdo may be compared with the tamest parts of Tibet lying to the east or south of these extensive highlands, where the absolute height descends from 16,000 to 12,000, or even 11,000, feet. Amdo stretches out far and wide to the south of the Alpine basin of Koko-nor, with more or less lofty undulations of ridges, mountains, and hills running east and west from the Hwang Ho in its upper course in the highlands. The chief ranges have a latitudinal direction with various deviations to the north and south. The snow line is absolutely above 15,000 feet. In the upper valleys, as in Tibet, are found characteristic meadows of hard Tibetan sedge-grass (*Cobresia Thibetica*), on which graze graceful mountain antelopes—*ada* (*Procapra picticauda*), and large Tibetan larks (*Melanocorypha maxima*) are plentiful, enlivening with their melodious song the monotony of the land. On the whole the mountains are rich in Tibetan forms of vegetation, from low-growing shrubs to alpine meadows; the animal life is also identical with the Tibetan. The traveller, however, does not meet with wild yaks, or the *orongo* antelope (*Pantholops hodgsoni*), which have been expelled by the dense nomad population.

Notwithstanding that the expedition travelled in Amdo in the very coldest month, January, its members did not experience extreme cold, especially when the route lay close to the deep, warm valley of the Hwang Ho, but as the expedition approached the mountainous region the winter made itself felt in all its severity. There was not wanting a covering of snow even in the valleys, where, otherwise, the grassy steppe, turned yellow, was studded with numerous herds of cattle; the black tents of the native inhabitants stood out curiously against the golden-coloured slopes of the hills free from snow, with brooks and streamlets running at the bottom, their frozen surface shining like silver in the bright sunlight.

The predominating population of Amdo consists of warlike Tibetan tribes, Tanguts, divided according to their mode of life into nomads and agriculturists. The Tanguts, like all mountaineers, live in scattered groups, which frequently are on hostile terms with one another They differ among themselves also in their dialects of their common Tibetan language, and in various interpretations of Tibetan Buddhism.

THE RIVER HWANG HO, A LITTLE ABOVE HUI-DUI.

GROUP OF ANDO MEN.

LABRANG MONASTERY FROM THE SOUTH-SOUTH-EAST.

LABRANG FROM THE EAST.

In political affairs the Tanguts form a separate independent tribe, only nominally subject to China. The Chinese do not interfere at all with the internal affairs of the warlike natives, and confine themselves to the very occasional despatch of officials with military escorts for the settlement of suits between Chinamen and Tanguts. The all-embracing Chinese culture influences only the outskirts of Amdo, where immigrant peasants and small traders have settled.

In Amdo, as is general over the whole extent of Tibetan national territory, no close political union can be established owing to the geographical conditions and the warlike, freedom-loving character of the inhabitants. Indeed, among the Tanguts there is a complete absence of any consolidated authority, and they are under the influence of one or another *gegen*, or monastery. The mutual relations of their social life are regulated by the national courts of elected elders, or by small chiefs and headmen.

In their predatory expeditions, which constitute one of the chief occupations of the Tanguts, they obey their leader or hetman. The Tanguts have no written laws, although they are comparatively well educated, but in their social life they certainly are guided by customary rights. The doctor is held inviolable in a neutral house or hamlet. Each community is bound to uphold the interests of its members, and if any one suffers injury from people of another community, then the community of the wronged man must demand compensation from the offending community and render material assistance to the family or heirs of the sufferer. At a rough calculation the number of all the Tanguts of the highlands does not exceed half a million souls of both sexes.

The agriculturists live in hamlets of mud and stone houses, surrounded by walls of the same construction, and each homestead forms a small fortress. The cattle grazers live in camps of hair tents, "banag." The natives of Amdo we saw do not differ outwardly or actually from the eastern Tibetans described in my book, 'Mongolia and Kam.' They have the same medium stature, rarely tall, the same thick-set, squat build, the same large black eyes, the same flat nose, sometimes also aquiline, and the same medium-sized ears. The dress and dwellings of the Amdo nomads are identical with those of the eastern Tibetans, and their manners and customs are very similar. Differences can only be detected by close observation of individual natives.

The male part of the Amdo population is fond of meeting together for frivolous conversation on all suitable and unsuitable occasions. The most the men do is to go hunting and robbing. The domestic work, such as tending the cattle, collecting fuel, drawing water, and, in short, everything, falls on the women. While the wife is working incessantly all day long the husband grows weary with idleness, and does not go to her assistance unless she is physically incapable of doing any work

at all. On horseback the women are as dexterous as the men—to catch any horse she likes out of the troop, lay her hand on its mane and quickly spring on to the back of the bare-backed steed, and ride off in any direction she wishes, is an ordinary feat for any young Amdo woman.

As the women pride themselves on their beads and silver ornaments, so the men take an equal or greater pride in their weapons, and spend no little money in adorning them with silver and stones. Martial aptitude, courage, and audacity in Amdo, as in Central Asia generally, are the qualifications appreciated as fitting men to be leaders. Mettlesome horses with loud-clinking trappings attract the attention from a distance of people by the roadside, or a caravan. Bright dresses—dark-blue, red, yellow—adorn the proud Amdo cavaliers, especially the officials, before whom the simple people bow their heads lowly and meekly.

One cannot help remarking in recent times a circumstance that must strike every observer—I mean the appearance among the Amdo people of European weapons in ever-increasing quantities. The numerous inhabitants one met with on the road or in camp were frequently armed with magazine rifles, kept in excellent order, with their rests for more accurate shooting, especially at wild animals in the valleys, contrivances always used by Central Asiatics with their primitive matchlocks. The Amdo men showed us their magazine rifles with pride, asking to be shown in turn our Russian rifles. They master admirably the details and construction of European weapons, and execute all kinds of manipulation with remarkable dexterity and intelligence.

In the most beautiful, most attractive, and convenient corners of Amdo are erected temples or monasteries, and at the latter are frequently established the seats of administration of the chiefs and the houses of their followers. Near the monasteries also the Chinese traders frequently have quarters, which, at the great centres, are collected into a separate colony. The chief monasteries in Amdo—Kumbum and Labrang—contain in their temples and numerous buildings thousands of lamas, professing, for the most part, the doctrines of Tson-Khava, or of the so-called Yellow sect. With the former of these monasteries I have already made my readers acquainted in the *Geographical Journal* for October, 1909, and to the other I shall draw their attention presently. Now we will turn to my journey.

Taking leave of the Hui-tê people, who were on excellent terms with the expedition, and also wishing a good journey to our comrades, we set out along an interesting route on the morning of January 19. We marched along at a round pace at first in the familiar oasis, and afterwards in the southern ravine of the river Ranen-zhatstson, which led us to the hot springs of Chi-hu. This was the beginning of our wanderings. We pitched our camp between the monastery and the hot medicinal springs. Our white tents stood out charmingly against a

golden background of grass (*Lasiagrostis splendens*) rising to the height of a man. This pleasant spot was already known to me from an excursion to the springs, which had a maximum temperature of 185°·4.

At dawn on the following day, January 20, the caravan set off in the same, southern, direction with the intention of emerging from the deep cutting of the Hwang Ho valley on to the adjoining plateau. As the upper streams and brooks formed many frozen cascades, we were obliged to cling to terribly steep cliffs of clay or loess before ascending to the heights, where we advanced more freely, and the caravan assumed again its proper pace. To the east of our route rose mountains, while to the west was displayed the valley of the Yellow river, at this season so much contracted that it looked like a huge dark snake. A nomad population took the place of a settled one. The summits of more ridges or hills came into sight, and new views, new valleys, densely populated by nomads and their herds. We kept a south-westerly course, and set up our night quarters in the neighbourhood of a Tangut encampment. As the caravan moved along we were accompanied by a whole cavalcade of mounted men driving up fresh baggage animals—yaks, for which we quickly exchanged our wearied horses and mules.

We intended to take our first day's rest in the Tangut principality Lutstsa, which we reached safely in five days' march from Hui-dui. The establishment of the Lutstsa potentate is situated in a valley of excellent pasture land, which we took a whole day to traverse, making our way towards a group of black tents, or *banags*. On approaching the encampment I was met by the son of the chief, a young, handsome Tangut, and the chief's household, and afterwards by the old man himself, "Lu-khombo," as he is called by the surrounding inhabitants, impressed by his strong veteran army. The chief invited me into his roomy tent, where the usual refreshments were already prepared—tea, with fresh cakes of very common flour just from the oven. The chief begged me not to stand on ceremony, but to eat and drink well. Brick-tea—flavoured with salt, milk, and butter—seems nauseous at first, but I was quite accustomed to this Asiatic beverage, and drank readily one cup after another. The son of Lu-khombo actually drenched me with tea, and kept piling on fresh cakes baked in mutton fat.

After the refreshments I wished to choose a site for the camp of the expedition, and both the young and old chief came with me to assist in deciding the question. We stopped at an open space lying about 200 yards from the chief's tents. Then the caravan came up, and was scarcely unloaded when the chiefs asked my leave to send all my companions tea after their journey. All seemed to be going on excellently, and the more so that an official Chinese interpreter from the Hsi-ning authorities accompanied the expedition, provided with all kinds of documents to secure the co-operation of the Amdo people. Having

entertained our young men, the chiefs and their suite proceeded to our camp and positively besieged it. The chiefs were invited into the officers' tent. Both showed a great liking for drink, and without any hesitation asked me for Russian spirits, holding up both thumbs as a sign of approval. When they had quickly emptied a bottle of brandy I put before them some very strong spirit kept in the stores of the expedition for preserving fish, snakes, lizards, etc. The princes approved of it, and the old man got a little drunk. Fortunately, his wife, a little decrepit old woman, came in most opportunely and led away the tipsy old man, who said on the way, "To-morrow we will talk of business, about your further journey; but I expect presents to-day." As a matter of fact he had received part of the presents, and the rest were sent after him immediately.

Two days passed in fruitless discussions, leading to no definite results. Whatever we proposed to the chiefs—more presents and very high payment for animals and guides—they still insisted on their "Give us your Russian rifle and case of cartridges and we will let you go free." When at length I was obliged, suppressing my anger, to agree to these terms, Lu-khombo said, "My son will go at once with you to examine your rifle once more, and I will go home." The son appeared, and going haughtily and arrogantly to the Cossacks' tent, he made a very careful inspection of our stores. At length, with his former haughtiness, he said, "Your gun is wretched, it is worth nothing," and went off. A trying time ensued, and in the end a determined attack was made on the camp at midnight, which was fortunately repelled.

In the morning, January 26, I complimented my brave fellow-travellers, corporals, lance-corporals, and sergeants, and explained to them the situation in which we unexpectedly found ourselves. Lu-khombo appeared, and also congratulated us all on our brave repulse of the attack, for which he blamed his neighbours. I asked him in a jesting tone if it were not his subjects who thought to play us such a nasty trick. To this the haughty old man replied, "I will cut them down with my own hand if any are seen wounded, and I will run through any of my people who dared to take part in the onslaught." Lu-khombo became furious, the wrathful eyes of the powerful old man shot out sparks; he quivered and turned his hetman's hat of foxskin mechanically about on his head; sometimes he also threw off the sleeve from his right shoulder, baring his back, scarred with wounds—the old warrior saw visions. Now, I believed that Lu-khombo never gave even the customary presents to any one, as he had told me on the first day of our acquaintance, but he himself took as much as he wanted from every one. For the first time, it seemed, the chief had to acknowledge his impotence. To avoid drawing on himself more suspicion, and to prevent us learning anything about the killed and

wounded—whom we did not hear about till after several days and marches—the chief of Lutstsa hastened to send us on our way, appointing his son to be head of the guides, and regaling us at starting with the indispensable tea and greasy cakes.

The men of Lutstsa positively refused to conduct the expedition to the monastery Rarcha-gomba, as I wished, giving as a reason for their reluctance the lofty snowy mountains on the way; but more probably they feared the N'golki, robbers also like themselves, who some time back threatened Lu-khombo with an incursion in return for former misdeeds of the old wolf. The chief prescribed to his son a long roundabout route, with instructions to hand it on to the son-in-law of the old man, who was bound to conduct the caravan under the same regulations to the line of the winding road lying within the domains of Rarcha-gomba and Labrang.

Such a long circuitous route, devised by the chief of Lutstsa with a view to increase the earnings of his relations and acquaintances, was of advantage to us also, as it gave us an opportunity of making acquaintance with very interesting unknown corners of the Amdo highlands. Truly, this exploration cost us much in physical, moral, and material wear and tear. Until we arrived at the monastery Labrang we lay down to sleep in our clothes, and did not part from our rifles; the night watch was kept very strictly, and was much strengthened. Those who took part in the winter excursion being so few, we had all to stand on duty during the night for five or six bitterly cold hours, and next day follow the road, making all kinds of observations and collections at a height of 10,000 to 14,000 feet above sea-level. The superstitious natives regarded our desire to make inquiries about their country, or to examine the mountains and break off specimens of rocks, as an injury to themselves, an interference of the Russians with their natural property. Our investigations had to be carried on by stealth. Our nerves were strained to the uttermost. One must have a deal of patience to endure all this and pay the thieves many times as much as is due.

Labrang, or Lavran, is a Tibetan word signifying the retreat, house, of a *gegen*. This great historical monastery plays a prominent part in the life of the nomads near and far. Thither stream periodically tens of thousands of Buddhists to pray in the sanctuaries of Labrang, and also to transact their business. Labrang is the younger brother of Kumbum, but surpasses the latter in wealth and splendour. The monastery is situated in a narrow, very charming valley surrounded by lofty mountains, which are clothed on the northern side by forest under the strict supervision of the monastery. In the bottom of the valley, close to the foot of the southern mountains, rushes impetuously a small limpid stream, the San-chu, that is, *pure*, one of the numerous headwaters of the Hwang Ho, rising in the Amdo highlands. Below the monastery, along this rivulet, are also patches of pine-wood, stretching up the mountains to their

summit ridges. In these woods our collectors freely hunted for birds, and were successful in enriching our ornithological collections with rare specimens: *Loxia himalayana*, *Lophobasileus elegans*, *Trochalopteron ellioti*, *Picus mandarinus*, *Ibidorhynchus struthersi* (on the mountain streams only), *Ithaginis sinensis*, *Crossoptilon auritum*, *Phasianus strauchi*, and some species of birds of prey. I can imagine how pleasant it must be at Labrang in summer, though even now, in February, we were enraptured on mounting the southern terraced bank. West and east wound the stream, north and south rose up mountains bathed in the glaring rays of the sun. The soft blue sky charmed the eye, the roar of the stream rose up from below, and the song of birds delighted the ear. Look up at the monastery in the distance, at its rich original construction, at the bright colours, the motley lamas passing in crowds from one temple to another, and you will find that it does not mar, but completes, a picture of singular beauty. Amidst the marvellous grandeur of nature man is admirably fitted into his religious environment.

Thanks to its geographical and ethnographical position, Labrang was not exposed to destruction in any of the Dungen insurrections, and to this circumstance it is due that the monastery far surpasses in wealth, and in the preservation of its monuments, other monasteries that have suffered spoliation.

As a monastery Labrang was founded about two hundred years ago by the hierarch Zhamian-shagba, now in his fourth re-incarnation. The founder only built a small cathedral church, established a school of Buddhism, and erected a few houses for the community of monks. In the establishment of this monastery special care was taken that Labrang should be favourably distinguished from others by the model discipline of its monastic life, the modesty and good organization of the community. In fact, the moral purity and exceeding modesty of the monks of Labrang, and the reputation of its illustrious chief hierarch, combined with the splendour of its shrines, attracted, and continue to attract, piously disposed Buddhists from all corners of Amdo. Labrang owes its pre-eminence to the second re-incarnation, named Zhigmeg-vambo, an energetic, intelligent man, and his pupil Guntan-Dambi-donme, who, by his works on Buddhist philosophy and his energy as a teacher, raised the Labrang *tsannid* school to a brilliant position.

Of the numerous temples of Labrang the *tsekchen-dukang*, the chief cathedral church, deserves special notice, and next the Serdun-chemo, or temple of Maitreya, belonging to the re-incarnations of Zhamian-shagba, which stands at the north-western extremity of the monastery. This temple has a golden roof, in the Chinese style. Within it stands a large statue of the Maitreya Buddha. As all *lhakangs*, Serdun-chemo has wall pictures. On the inside wall to the left of the entrance a large inscription is written on linen cloth. This inscription sets forth in the Tibetan tongue the history of the temple, and gives an inventory of the holy

relics deposited in it. Among other things are enumerated the sacred objects of reverence which are placed within the statue itself. Among these may be mentioned, as the most precious of the enclosed relics, the Sanscrit manuscript on palm-leaves of the treatise of the teacher Buddhapalita on the philosophy of the mean.

Labrang has the honour of containing the very first metal figure of Buddha, once, according to tradition, in the possession of the founder of the Buddhist faith. In the Labrang treasury of knowledge, the library temple Bain-zet-lhakang, old Indian and Tibetan works are preserved.

Round the monastery, except on the north, where it abuts on the mountain, and joined on to it, are built sheds with rotating cylinders—*khurde*. The faithful Buddhists and lamas, performing all day long their religious pilgrimage round the monastery, turn the cylinders as they pass, with the holy writings within them. It should be remarked that *khurde* of this kind frequently mark the boundaries of the monastery precincts, and no monk's cell may be placed beyond the limit of these cylinders. This would be a breach of the monastery regulations, and also contrary to the conviction that peace and happiness must reign within the lines of the cylinders.

At the time of our stay at Labrang the head of this monastery was absent. His place was taken by two of his older assistants—one for temporal and the other for spiritual affairs. With the former, named Guntan-tsan, a re-incarnation of one of the vicars of Tson-khava in Lhasa, I formed a close acquaintance, and received from him permission to take photographs, not only of a general view of the monastery, but also of its principal temples individually.*

There is a high school at Labrang, a kind of university or ecclesiastical academy, and four schools of the second rank, among them the Mandadukang, or medical school. This enlightening education is taken advantage of by young lamas from Tibet, Amdo, Mongolia, and even by Buriats from our own, Russian, Transbaikalia, and the professors and prominent teachers are lamas of the place or from Tibet. The lama students consider the best lecturers to be two meritorious professors, Khori Ronsyl, in theology, and Guntan Lodön, in Buddhism generally. Now, as formerly, the lamas, after completing the course in the Labrang University, go for some years to Lhasa, to finish their education. The whole monastic community in Labrang numbers almost three thousand, with a hundred *gegens* of higher and lower rank and re-incarnations. At Labrang the expedition added the best specimens to its collection of images and Tibetan books.

From Labrang the expedition set off, towards the end of February, in

* The spiritual assistant, a strict, venerable old man, was a re-incarnation of one of the rectors of the classical school in Lhasa. He is considered an eminent scholar and student.

two parties. The main caravan I despatched by the shortest direct route to Lan-chou-fu, while I myself, accompanied by the Chinese interpreter, Poliutof, travelled thither by a circuitous route through Hsi-ning to thank the Tsin-tsai of the town for all his work and trouble on behalf of the expedition. Just at this time the Dalai Lama returned to Kumbum, and I was fortunate in meeting again * the pope of Buddhism and the supreme ruler of Tibet. The Dalai Lama received me with his former amiability and obligingness. I passed more than a week in Kumbum, and visited daily the Labran of the Dalai Lama, and we spent many interesting hours together. Trips to Peking and acquaintance with Europeans have made a remarkable impression, not only on the Dalai Lama and his ministers, but also on all his suite.

Taking leave of the Hsi-ning authorities, I proceeded, towards the end of March, to Lan-chou-fu, where the caravan had been waiting my arrival for two weeks. Lan-chou-fu, the residence of the Viceroy, or Governor-General of the province Kan-su, is finely situated on the right bank of the broad, rapid and voluminous Hwang Ho. In this populous commercial town there is life and movement; the streets are full of people, stores, goods imported from Peking and the rich Sze-chuan. There are not a few Europeans there—missionaries, engineers, technicians, and other business men. Across the Hwang Ho runs the European post. A singular and original picture is presented by the four historical bastions of Lan-chou-fu, built on the hills overlooking the town on the south-west, that once arrested the terrible advance of the Dungans from Ho-chou. The garrison of the town consists of men of all arms, and numbers six thousand soldiers, armed and trained in European style. The soldiers I saw seemed proper young men, accustomed to discipline. The military signals are European, and we heard them daily at the morning and evening watches which regulate the duties of officers and soldiers.

In Lan-chou-fu we were fortunate in adding to our ethnographical collection specimens of ancient Chinese art, particularly bronzes. Many striking objects, however, we could only admire, as they cost more money than we had to dispose of near the end of our journey, the systematic collection of objects of the Buddhist cult, which was included in our programme, having dipped heavily into the budget of our expedition, or, rather, exceeded it. Thence I despatched to Wei-yüan Hsien a valuable reinforcement to my assistant, Captain Napalkof, placing at his disposal a third companion, the grenadier Demidenko, to act as collector of plants and insects.

In Lan-chou-fu we were able to hire Mongolian drivers, and we proceeded to Alasha-yamin by the great Alashan road with a caravan of camels. This pleasant journey we accomplished in two weeks. The

* My first meeting with the Dalai Lama was in the summer of 1905, in Urga.

weather was splendid. Warm sunshine poured down on us every day. All our troubles were forgotten. Even our feathered companion, a hooded vulture (*Vultur monachus*),* having rested at Labrang and Lan-chou-fu, now bore the journey easily on a baggage camel. We wrapped him in cloths like a baby, and placed him in a basket with an opening for his head. On arriving at camp, the vulture was allowed full freedom and was given a good piece of meat. In this way our involuntary companion accomplished a journey of fully 2000 miles with the caravan, and 4600 miles more by steamer and rail before he arrived in St. Petersburg in the waggon containing the collection of the expedition.

Easter found us in the Alashan desert, and on April 19 we reached our depôt and meteorological station in Ting-yüan-ying, where we found all satisfactory and in good order.

The oasis Ting-yüan-ying had put on its spring dress under the influence of the warm rays of the sun. The air was heavy with odours from the budding fruit trees. Swallows flew about twittering cheerfully. But the finest sight in Alashan is the Alashan range, which, in the transparent state of the air, presented an enchanting spectacle, especially at sunset, when violet or blue haze lay on its steep flanks, charming to the eye. The Alashan range extends in an almost meridional direction, and rises grandly above the adjoining plain. The flanks are very steep, and the crest and ravines rocky and stony. In consequence of the steepness of the slopes the water runs off quickly, but still the range abounds in vegetable and animal life, and its recesses recall to mind the eastern Nan-shan. In short, the Alashan range contributes greatly to the well-being of its inhabitants, though they do not know how to exploit its resources properly. They are justly proud of the culminating summit, Bain-sumbur, which is reverenced as sacred. At the large *obo* which crowns this summit the Mongols assemble every year in summer to hold their services and keep their customary feasts.

Two fine rich monasteries of the Alashan tribe are also built in the mountains. One of them, Barun-khit, stands 20 miles to the south-east of Ting-yüan-ying; the other, Tzun-khit, at the same distance to the north-east. Both monasteries are situated in beautiful ravines surrounded by picturesque slopes, against which rise precipitous cliffs, frequently decorated with mystical formulæ or even the deities of the Buddhist Pantheon.

Obos, oratories, and tombs lend a peculiar charm to the nooks of the monasteries. Tzun-khit is noted for its strict rules and its regular performance of religious services, continuing the tradition of the famous Alashan lama, Dandar-lharambo, who compiled the best grammar of

* I bought this large bird of prey from a Chinaman in Hui-tê. He soon became accustomed to us, but he regarded Chinamen and Tanguts as enemies, and was always quarrelling with them. He had a still greater dislike for strange dogs, and attacked them furiously with his sharp talons.

the Mongolian tongue, and also translated several Tibetan books into Mongolian. Barun-khit cherishes proud memories of the fifth Dalai Lama, who was in this monastery, and here found a resting-place. In one of its shrines stands the tomb containing the sacred remains of Tsain-chamtso.

The past history of the Alashan Mongolian principality is as follows.* Until the arrival of the Mongols in Alashan, or Alasha, as the aborigines call it, the district known by this name, bounded on the east and south by a cultivated zone with a Chinese population, on the west by the nomad Torgouts of Edzin-gol, on the north by the territory of the Mongols of Khalka, and lastly, on the north-east by the nomad Urots, remained uninhabited, though roads crossed it in all directions. At the commencement of the rule of the second Bogdykhan, of the dynasty now reigning in China, disorders arose in the Ili territory among the Olöts, and about a thousand families, headed by a *taichi*, were forced to retire from Ili to Alasha. The refugees settled chiefly in the Yabarai mountains, whence they made bold excursions beyond the Alashan range both to the north and south of their headquarters. Like a vigorous spider the warlike *taichi* extended the network of his raids over the sands, and soon sent forth his forces to the lower region of the desert. Thus passed twelve years, in the course of which the chief mass of the new-comers never left the Yabarai mountains. At the expiration of this period the Chinese authorities tried to crush them, but though they punished the Olöts severely, the attempt was not successful. However, the *taichi* and his most intimate counsellor, known by the appellation of Gantsy-riudutei-lama—that is, the "one-eyed lama"—saw that sooner or later they would have to pay for their brigandage, and in order to secure in future undisturbed possession of the lands they had occupied, resolved to make their submission to the Bogdykhan.

In the thirty-seventh year of the administration of the existing Manchu dynasty, that is, in 1681 A.D., the *Taichi* and the one-eyed lama, accompanied by Olöts of more or less influence, repaired to Peking, where they were affably received by the Bogdykhan, Kan-su, a contemporary of Peter the Great. The Olöts unreservedly confessed their misdeeds, their depredations and robbery, citing as an excuse the dire necessity which forced them to seek means of subsistence. But they were convinced that such violent practices were not good, and they appeared to request that legal rights might be granted to them over the uninhabited districts. Their confession was accepted, their transgression condoned, and, moreover, the Bogdykhan deputed an official to go with the *Taichi* and define the territory reserved for the wanderings of the Olöts. The boundary then fixed remains in force to the present day.

* P. K. Kozloff, 'Mongolia i Kam,' vol. 2, pp. 674 *et seq.*

DARK LILAC SANDSTONE BETWEEN LABRANG AND KUMBUM.

THE ALASHAN RANGES FROM THE WEST.

TZUN-KHIT MONASTERY, ALASHAN MOUNTAINS.

KHARA-KHOTO FROM THE NORTH-WEST.

On the *Taichi* was conferred the princely rank of *beile*, and a household corresponding to his new rank. The Mongols abandoned brigandage and adopted a peaceful occupation—cattle-grazing. The Bogdykhan exempted the population of the "sandy region" from all services and imposts. This privilege became known in the neighbourhood, and in the domain of the *beile* the Mongols spread everywhere with their property and herds, and the population increased rapidly. At the end of the life of the third *beile* the tribe numbered about ten thousand households, rich in herds of camels, and also owning a comparatively small number of other animals, especially horses. At any rate, the fame of the Alashan tribe, as one of great wealth, soon reached the court of Peking.

At the time when the fourth *beile* was ruling over the tribe, the Dungan-Salar insurrection broke out in Kan-su, and the Alashan Mongols, at the command of the Bogdykhan, were obliged to take an active part in its suppression. The Alashan *beile* relieved Lan-chou-fu, and checked the advance of the Salars to Koko-nor by the construction of a fortress, known by the name of Bar-Khoto, the ruins of which lie in the valley of the stream Tsunkugin-gol.* The Salars were not only stopped, but were cut to pieces.

After this exploit the *beile* was honoured with the princely title of *tsin-van*, and at the same time the Bogdykhan gave him one of his daughters. All the above events occurred in the forty-seventh year of the reign of Tsian-lun, fourth Bogdykhan of the Manchu dynasty.

On sending his daughter to Alashan, the Bogdykhan presented to the *tsin-van*, besides the dowry and Manchurian servants, ten thousand *lan* of silver for the erection of a palace in the fortress Ting-yüan-ying, and as much to distribute among the Mongolian population. Accordingly, the Chinese princess was accompanied by a large train, in which were a hundred Manchu families, former retainers of the daughter of the Bogdykhan, and a whole company of actors, with all the accessories necessary for theatrical representations. Until this time the Alashan *beile* had no permanent dwelling, but lived in yurts moving from place to place with his herds.

For the arrival of the princess the fortress Ting-yüan-ying was extended. New town walls were carried round it, and within was erected a palace, with servants' quarters, a theatre, etc. The trade of the new town quickly increased, but, on the other hand, from the time when the Alashan *vans* began to intermarry with royal blood the expenses increased of maintaining a large number of Manchurian retainers, and the profuseness and luxury of the court of the *vans*. The population of Alashan became impoverished and decreased in numbers. The greatest height of prosperity and the maximum number

* On Bar-Khoto, see 'Mongolia i Kam,' vol. 1, pp. 160–161.

of inhabitants (ten thousand families) were attained under the rule of the fourth *beile*. Now the number of the Alashan people has fallen to eight thousand souls, and probably is still declining, for the imposts are no less, but, on the contrary, are growing every year. In recent times, not only the *vans* themselves, but all their sons, have married Chinese princesses, with whom, as before, numerous Manchurian retainers have come to Ting-yüan-ying. For a residence in Peking the *van* has built a mansion which far surpasses his palace in Ting-yüan-ying in richness and luxury.

Of Olöts proper there are now in Alashan not more than four thousand souls, or the half of the total population, the other four thousand being composed of immigrants—Khalkhi, Torgouts, Kharchins, and others of Mongolian nationality. In Ting-yüan-ying itself the population is still more mixed—it consists of two hundred Manchurian families, almost as many Chinese, a hundred and fifty Mongolian families, besides a hundred lamas and about eighty cavalry soldiers on duty at the court of the prince.

If a traveller wishes to see a pure-blooded Mongolian Olöt in his native dress and surroundings in eastern or southern Alashan, he will hardly be able to satisfy his curiosity. The Alashan people of these parts are nearly assimilated to the Chinese; the men, and even the women, wear Chinese dress, have introduced Chinese furnishings into their yurts, eat Chinese dishes out of Chinese earthenware, sing Chinese songs, and, when necessary, speak Chinese, though they have preserved the Mongolian language in more or less purity, except the pronounced Chinaists, who interlard their colloquial speech not only with single words, but with whole phrases. Chinese civilization has particularly influenced the rich Mongols and officials, who build themselves houses of Chinese architecture instead of yurts.

At the court of the Alasha *van* Chinese is used exclusively. The present *van* and his eldest son and heir do not speak Mongolian, except a few words and phrases they have picked up, which they pronounce with a Chinese accent.

Where the Mongols and Chinese are in closest contact the migratory life of the former is gradually being abandoned, and, cattle-grazing declining, this part of the population has resorted to cultivation and the transport of goods from Alasha to Kalgan and Peking. The Alashan people also willingly convey numbers of pilgrims to Kumbum, Labrang, and even to Lhasa. The people in the more remote isolated parts of Alashan still endeavour to preserve their Mongolian character, still occupying themselves in cattle-grazing only, as in former times. But there, too, the male element is beginning to dress in Chinese clothes, and the young dandies do not object to adorn their heads with Chinese hats, and put their feet in Chinese shoes made of plush or lasting. The older women still adhere obstinately to their national costume, especially

the sleeveless *tsegedek*, their head ornaments, and their mode of hair-dressing.

Besides these outward marks of a tendency towards Chinese fashions, the Alashan natives are also become almost Chinese in mind and habits and customs. They adopt from the Chinese their serious deportment, and all the Chinese ceremonies in meeting and taking leave of guests. These Mongols have already ceased to hold their feasts in Mongolian style. The new year is celebrated in Chinese fashion. There is no more racing, wrestling, etc., but drunkenness is prevalent, and the urban population is addicted to opium and to playing hazard for money. Constant association with Chinamen, with devotees and traders, have made the Alashan people sly, mean, greedy, and impudent tricksters, surpassing even the Chinese.

Resting a day or two in Ting-yüan-ying, we diligently set to work to sort our baggage and pack up the collections, and also to make all kinds of preparations for a journey in the desert in summer, and our work in the ruins of Khara-khoto. Towards the middle of May Captain Napalkof joined us, having accomplished another interesting journey through Kan-su for the purpose of completing the cartographical work of the preceding year. Now the sections of the expedition were all gathered together, and the baggage and collections were piled together; but this was not for long, for two roads lay before us—one to Khara-khoto, the other to Urga. Along the former I set out on May 17, lightly equipped, with the majority of the men—nine with myself—while along the other my assistant, Captain Napalkof, started on the 22nd with the main caravan, four men in all.

The whole journey from Ting-yüan-ying to Khara-khoto, 360 miles, was accomplished in nineteen days. It is a country of extreme desolation, consisting partly of smooth, sandy, and stony ground, partly varied by stony ridges and hills shutting out the horizon, and only here and there, in the hollows, relieved by green desert forms of vegetation—saxaul (*Haloxylon ammodendron*), tamarisk (*Tamarix pallasi*), nitraria (*Nitraria schoberi*), and a few other shrubs putting forth yellow, white, or light pink blossoms. The warm air was filled with the buzzing of insects. On the surface of the ground sharp- and flat-headed lizards darted about, beetles crawled, and snakes wriggled unpleasantly. Of the feathered tribe, indigenous or permanent forms predominated—the hooded vulture (*Vultur monachus*), two or three species of hawks, the desert chough-thrush (*Podoceps hendersoni*), larks (*Otocoris* and *Alaudula*), and the very characteristic bird of the desert, the sand grouse (*Syrrhaptes paradoxus*), the last often frightening our baggage camels as it rose from its nest. As for mammals, the graceful gazelle *khara-sulta* (*Gazella subgutturosa*) frequently appeared in sight, as before, giving our hunters a trial of their skill. Our zoological and botanical collections were added to. Nomads with herds of cattle were met with

at the wells, whither we resorted to pass the night. We usually set out with the dawn and went to rest at nine o'clock, after taking the evening meteorological readings. The time passed quickly, almost imperceptibly. The ruins of Khara-khoto had an irresistible attraction for us, and we spoke of them daily.

This time the route of the expedition, just after passing the well of Durbune-shoto ("Four Trees"), diverged to the north to the monastery Shartzan-sume, where we reckoned that we had traversed about half the distance to our destination. This point was fixed astronomically. The inmates of the monastery, a hundred monks, who follow the teaching of Tson-khava, are zealously concerned for the wealth and reputation of their small temples.

At a day's march from Shartzan-sume, at the well Tzasin-khuduk, where a Mongolian lama, Ishi, was staying, we spent a whole day. After we had obtained fresh camels the expedition marched at a better pace. The desert displayed the same scenes as before, sometimes even more dreary. We now met only with herdsmen feeding camels; we saw no other kinds of domestic animals, and the men were obliged to subsist on dry mutton preserved in fat. So we went on to the oasis Goitso, where we proposed to pass a few days, or at least to traverse it in short marches.

The Goitso basin * extends in a longitudinal direction for a distance of 50 miles. Though the bare sandy stretches in it predominate over the parts covered with vegetation, still, compared with the surrounding desert, it well deserves its designation "beautiful." Abundant water, supporting a comparative profusion of animal and vegetable life, makes it a permanent oasis, and it seems hardly credible that such a place can exist in the central Gobi. To the nomad, forced out of the desert, it cannot but appear a veritable paradise. We passed on our outward journey along its southern edge, and on our return journey along the northern, thus gaining a knowledge of its general characteristics.

Along the northern and southern margins of the basin extend escarpments of the Han-hai formation, composed of clay, sandstone, and conglomerate. The bedding is horizontal, and terraces are accordingly formed, fantastically scored at the edge by deflation. In places they are eroded more deeply into groups of fragments. To the south of these terraces outcrops of older rocks were not observed, but to the north they form ridges with upstanding summits known as the Western, Central, and Eastern Khairkhani.

On the southern side of the basin, along the terraces of the Han-hai, extend high sand-dunes, in parts descending lower so that the escarpments of the Han-hai deposits are separated from the central parts of the hollów by a belt of quicksands. Similar sand-dunes, but of smaller dimensions, are seen also on the northern flank of Goitso.

* The absolute height of the basin is 2700 feet.

The central part of Goitso is covered with bushy mounds, among which lie bare patches of clay or fresh-water basins of considerable extent. The clay patches are more numerous in the western part of the basin, which is more even, sand hillocks being few, and their place being taken by sandy saline steppe overgrown with reeds.

On our outward journey, in the middle of April, we noticed many swimming and wading birds resting on their passage northwards. The pools were covered with various kinds of geese and ducks, among which we remarked widgeons and swans, and along the banks not a few snipe, grey herons, small grey cranes, and one or two other birds. Day and night the neighbourhood was enlivened by the cries of these strangers, or the rustle of their wings. Now, at a later season, the nesting time, we noticed the same birds, but in smaller numbers, and among Passeridæ or singing birds we came upon blue-throated warblers, greenfinches, and reed warblers, not observed before, which filled the spring air with their song.

As to animals, I obtained there an interesting wild cat of a beautiful tiger colour, killed on the eve of bringing forth young, and the kittens were added to our collection in spirits. The Mongolian population is concentrated in groups of *yurts* in small numbers all over the basin. In the eastern half, near a spring, some *gegen* has erected a large *obo*, where, in summer, the Mongols congregate to hold services and keep holiday.

Beyond the Goitso basin we again entered the desert. The heat in the daytime increased, especially on the bare plains of sand or salt clay, frequently veiled in a haze of grey dust through which the sun looked as a pale disc. In the desert we had to press on with long marches. At length, on June 4, at midday, the expedition reached the dead town of Khara-khoto and set up its bivouac, not in the centre of the historical wall as before, but somewhat nearer to the north-western corner by the ruins of the great building. During our twelve months' absence no one had visited it, and the ruins were in the same state as when we left them.* The articles, too, which we had extracted from underneath *débris* and rubbish, and left behind as useless, were untouched.

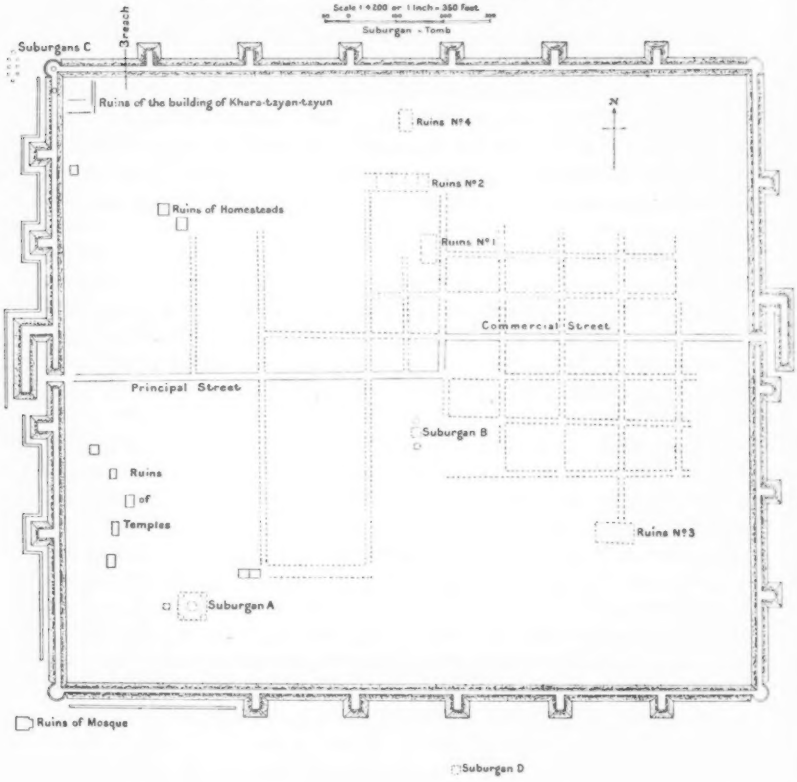
Counting on spending about a month in the work of excavation, I renewed our friendly relations with the Torgout *beile*, living on the Edzin-gol, 13 miles from Khara-khoto, and secured his co-operation in hiring diggers, and also contracted with the Torgouts at a fixed price to bring us water and mutton daily from the Edzin-gol.

The excavations were carried out in accordance with a previously arranged plan. The party of Mongolian workmen, under the superintendence of my Buriat attendant, systematically explored the buildings

* It should be mentioned that piles of stones still lie on the walls of Khara-khoto, with which the besieged defended themselves.

along the few streets of Khara-khoto, while the Russian party, besides excavations within the town, carried out investigations outside the walls of Khara-khoto, near and far. Now, as on the former occasion, articles of domestic use, of simple luxury, and of worship came to light, and also manuscripts, documents, metallic and paper money, etc.* The

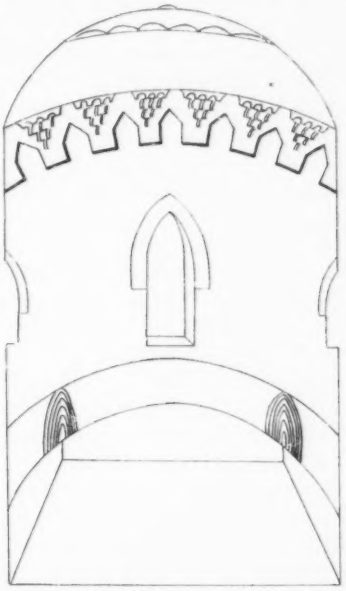
PLAN OF THE RUINS OF THE TOWN OF KHARA-KHOTO



similarity and poverty of our finds at length wearied us, and our efforts slackened. Meanwhile investigations were undertaken to discover and concentrate our energies on new excavations, with the result that we turned to the tomb situated outside the fortress, about 300 yards from the western wall, and on the bank of the dry channel. This tomb was

* During our diggings on the Khara-khoto ruins we caught a very interesting nocturnal lizard, a steppe snake, and a flying mouse.

called by us "the Grand," and henceforth occupied all our time and attention. It yielded us a large collection of books, rolls, manuscripts, and a quantity of specimens of Buddhist paintings executed in colours on thick linen cloth, on thin silken material, and on paper. Among a quantity of books and paintings, piled up in the most complete confusion, very interesting statuettes in metal and wood were discovered of high and debased art, models of tombs, and many other articles. The value of the discovered articles was much enhanced by the wonderfully excellent condition in which they had been preserved in the exceedingly dry desert climate. Indeed, most of the books and manuscripts,* and even the paintings, retained a striking freshness after having lain in the ground for several centuries. Not only the leaves of the books were in good condition, but also the covers of paper or silk, most of them of a blue colour. With all these treasures was interred a *gegen*, probably, the bones leaning in a sitting posture against the northern wall of the tomb.



CROSS-SECTION OF THE RUINS OF THE MOSQUE IN KHARA-KHOTO FROM THE ENTRANCE SIDE.

The tomb itself, as may be seen in the accompanying illustrations, rises above the ground to a height of 25 to 30 feet, and consisted of a base, a middle course, and a conical top, half destroyed by time or the curiosity of man. In the centre of the base was fixed vertically a wooden pole without any kind of ornamentation at its top. On the floor of the tomb, round the pole, facing towards the centre, stood as many as twenty large clay statues of life size, before which lay large books, just as before lamas reading their services. These books were of a thick paper of Chinese make with the letters Si-sia, generally found among the manuscripts of Khara-khoto.

Collecting from the tomb all these articles, which doubtless will throw much light, not only on this extinct historical capital of the Tanguts and its inhabitants, but also on many other subjects, we began to make ready for the road. Our caravan was increased to large

* Manuscripts were found in the Chinese, Tibetan, Manchurian, Mongolian, Turkish or Arabic languages, and in an unknown tongue.

dimensions, and we felt some anxiety lest everything should not reach home safely. The absolute height of Khara-khoto, from careful observations on the spot, was found to be 2854 feet. The geographical co-ordinates are: lat. 41° 45′ 40″, and the longitude from Greenwich 6 hours 44 minutes 20·99 seconds, equivalent to 101° 5′ 14″·85 E.

Our camels arrived on June 28, having all this time been kept at distant pastures in the neighbourhood of the monastery Shartzan-sume. Then, on the following day, we left the place. The camel caravan took the expedition to the Edzin-gol.

The valley of the lower Edzin-gol was particularly attractive after the desert, but, nevertheless, it did not detain us long, for there, besides the oppressive heat, were blood-sucking insects—gnats and gadflies—which persecuted us and our animals more than ever. We stayed two or three days, and then continued our journey,

In spite of fatigue and oppressive sultriness, the expedition travelled in rapid marches from the lower Edzin-gol to Gurbun-saikhan, partly because the greater part of the route had been already explored by us in the spring of the previous year. On arriving at Gurbun-saikhan, some of us were extremely exhausted, and my constant companion, old Ivanof, almost passed away on the road thither; at any rate, he gave me a great fright.

At the very height of summer, in the best season for the development of animal and vegetable life, the expedition reached the eastern edge of the Mongolian Altai, setting up its chief camp conveniently at the southern foot of Dungu-saikhan,* and made excursions far and wide in the region of this central massive. In order to gain a knowledge of the natural history of the country, and collect specimens, as well as to recruit our strength, exhausted by very trying though extremely fascinating work in the sultry, waterless desert, we spent two weeks here in the best part of the year, in a comparatively cool climate, on emerald meadows, through which silver streams flowed in capricious windings.

The three ranges—western, middle, and eastern—composing the massive of Gurbun-saikhan, rise from a broad common base. Though the lowlands skirting the massive are much lower on the north than the south, the base seems particularly imposing from the northern side. This is due chiefly to the difference in the steepness of its flanks, and also to the abrupt form of the rocky parts of the massive. In the eyes of the nomads the Gurbun-saikhan mountains possess great advantages in the abundance of their rich pastures and in their cool summers. According to the Mongols, the crest of the range is often white with snow in July, while on the middle and lower zones of the mountains fertilizing rains fall. Arboreal vegetation is almost entirely absent

* Gurbun-saikhan, *i.e.* three distinct (massives): Barun-saikhan (western), Dungu-saikhan (central), and Tzun-saikhan (eastern).

from these mountains, and there is comparatively little brushwood, but meadows of alpine grass are plentiful. Besides herds of domestic cattle, mountain goats (*Capra sibirica*) may be seen, and more rarely mountain sheep; both are hunted by the Mongols with matchlocks. The mountain slopes are honeycombed with the holes of marmots and numerous picas (*Lagomys*), which foxes and polecats lie in wait for. Hares are very common, and also susliks and wolves, the latter frequently making havoc among the flocks of sheep. Among birds, birds of prey predominate, both in numbers and in the variety of species. In the craggy part of Dungu-saikhan we managed to kill, among other birds, some specimens of the snow pheasant (*Tetraogallus altaicus*) of the Altai, which in these mountains reaches its eastern limit of distribution.

Crossing the Gurbun-saikhan between its central and eastern sections, the expedition marched to the north of the route explored by me in my last journey in 1899–1901 in Central Asia,* and reached Urga early in August, and on the 22nd of the month set out with the united caravan to Kiakhta, on the frontier of our own territory.

Now my Mongolia-Sze-chuan journey was at an end. In conclusion, I would enumerate the results obtained by the expedition.

A traverse survey was executed on the scale of 10 versts (6·6 miles) to the inch of more than 6700 miles of route, based on a network of astronomically fixed points. The heights of inhabited points on the way, of passes, valleys, and places where the expedition made a longer or shorter stay, were determined by barometrical readings. Meteorological readings were taken both in the main caravan and on lateral excursions, and, besides these, a meteorological station of the second order was established in the middle of the route of the expedition, in the town of Ting-yüan-ying, and was in continuous working order for twelve months. The island in Koko-nor, Kuisu, was explored, and the depth and the composition of the bottom and of the water of this alpine basin were ascertained.

Abundant collections were acquired—geological, botanical, zoological, and a very full collection of ethnographical objects, comprising Mongolian and Tangut garments, and, to a large extent, religious articles—some hundreds of painted representations of the deities of the Buddhist Pantheon, and an interesting collection of Tibetan religious books, not to mention Chinese works of art and also Chinese antiquities in the form of vases of original design, images, perfuming pans, etc.

Numerous photographs were taken of views and types in the places we passed through.

In the central desert of Mongolia, in the neighbourhood of the low country of the Edzin-gol, were discovered the ruins of the capital of the Tangut kingdom, Si-sia, the dead city of Khara-khoto, and the

* P. K. Kozloff, 'Mongolia i Kam,' vol. 1, pt. ii., pp. 706 *et seq.*

expedition loaded itself with scientific treasures, which, no doubt, will throw new light on Central Asia in former times beyond what the archæological section of the Asiatic Museum of the Imperial Academy of Sciences affords.

FEATURES OF ALPINE SCENERY DUE TO GLACIAL PROTECTION.*

By Professor E. J. GARWOOD, M.A., Sec. G.S.

1. Introduction.
2. The Plateau.
3. Arêtes.
4. Cirques.
5. Hanging Valleys.
6. Valley Steps.
7. The Steep South Side of the Alps.
8. Conclusion.

1. Introduction.

When we review the progress that has been made in the study of Physical Geography, or, more strictly, Geomorphology, during the last few years, we find nothing more striking than the revived interest in the features characteristic of glaciated districts. Thus the Alps, Himalayas, Scandinavia, Alaska, and New Zealand have in turn received attention. On the whole, there appears to be a strong consensus of opinion that glacial action has been a much more potent agent in the production of Alpine scenery than was formerly imagined. The monumental work of Penck and Brückner on the Alps in the glacial period,† founded as it is on carefully observed facts, must long remain a classic work on this fascinating region; while Prof. W. M. Davis, in America, has applied the deductive method with the scholarly thoroughness which distinguishes all his writings. These authors, together with Hess, Tarr, and others, have all been led to assign to ice-erosion a very important part in the formation of the features peculiar to Alpine scenery. Their views may be summed up in the words of Prof. Davis: "The rate of glacial erosion, in whatever way it may be accomplished, need not be very rapid, the only requirement in this respect being . . . that it shall be significantly more rapid than normal erosion." ‡ This is really the crux of the matter. Does an ice-cap lying on a plateau carve the surface more rapidly than the normal weathering agents? Do snow and ice lying on ledges, or resting in gullies, degrade more rapidly than do frost or water? and does a glacier overdeepen its bed more rapidly than would a river flowing in the same valley?

The difference of opinion in this respect dates from some years back; as long ago as 1888 Mr. Douglas Freshfield published a paper in this Society's *Proceedings* on "The Conservative Action of Ice," while Prof. Bonney has more than once expressed very similar views.

No one with any knowledge of glaciated regions doubts that moving

* Royal Geographical Society, June 20, 1910.

† 'Die Alpen im Eiszeitalter.' Leipzig: 1909.

‡ W. M. Davis, *Q.J.G.S.*, vol. **65**, p. 313.

ice erodes; that is not now the question.* The whole problem turns on the *relative* rate of erosion accomplished by ice as compared with that which would take place over the same district by ordinary erosive agents, namely, weathering, wind, frost, rain, and running water, more especially in a district which is partially covered and partially free from ice.

It may eventually be proved beyond doubt that ice is the greater erosive agent, but this has not been done. It may also be shown conclusively that all the features to be presently described can be satisfactorily accounted for by ice erosion; but so far this is not the case. It is intended in the present communication to consider more fully than has yet been done, what characteristic Alpine features might be developed on the assumption that *ice, on the whole, erodes less rapidly than other denuding agents, and that, under certain conditions, it may act relatively as a protective agent.*

2. The Plateau.

Let us consider, in the first place, a tableland on which snow accumulates during a glacial period. This snow gradually compacted into ice will cover the plateau and protect it from all the ordinary weathering agents of a temperate climate, including the action of frost, just as effectually as if it were covered by a deposit of impervious clay. Any erosion, then, that the ground beneath sustains must be due to the action of the ice itself. Erosion from this cause must be very slight indeed, as the motion will resemble the creep of a sheet of lead covering a counter, and the chief movement will take place in the upper layers. It seems practically certain, then, that an ice-covered surface which is on the whole horizontal will be relatively protected, and that the tablelands and plateaux in a glaciated district will have their pre-glacial features to a great extent preserved; the sharp edges of a plateau, however, where snow cannot lie continuously, but must melt and slide in summer, will not be protected in the same way, but will be subjected to other denuding agents. This fact was vividly brought home to the writer during two visits to Spitsbergen. Here plateau protection reaches its most marked development, while the plateau edges show some of the most remarkable examples of symmetrical river drainage to be found in the world. This is due to the present climatic conditions; the snow accumulated on the plateau during the long winter night melts continuously during the summer day, thus supplying abundant water, which, pouring over the plateau edge, sculptures the flanks into the almost ideal drainage system shown in Plate I. Fig. 1. Similar features on a smaller scale are constantly found in the Alps: a good example is the old Badile plateau, near the head of the Bondasca valley, shown in Plate I. Fig. 2, where the stream has cut back its headwaters into the old plateau step by step as the ice melted back and ceased to afford protection.

* Garwood, "Hanging Valleys in the Alps and Himalayas," *Q.J.G.S.*, vol. **58**, 1902.

3. Arêtes.

The symmetrical ridges known as *arêtes*, found in so many mountain districts, are essentially characteristic of glaciated countries. Their notable feature is the wonderfully even grade of their crests, cutting the sky-line in a distant view as though (as noted by Ruskin) drawn with a ruler, or slightly concave, resembling the most perfect denudation curve (Pl. II. Fig. 1). Many of these *arêtes*, however, on a nearer view, show the presence of sharp projecting towers of rock, the "gendarmes" so well known to mountaineers, which figure so prominently in accounts of Alpine ascents. The *arête*, indeed, is the route most usually followed during ascents of the higher peaks, as it forms generally, not only the safest, but often the quickest and least tedious route to the summit, on account of the even slope of its crest. It is curious that this even character, which, as stated above, is essentially a feature of glaciated regions, has not received more attention. It cannot have been produced by water-erosion, and cannot be considered a feature retained from pre-glacial times; neither would the disintegrating action of frost alone account for its symmetrical character. It appears to be essentially a case where ice protection may be legitimately invoked. At the beginning of a glacial period snow would gradually accumulate above the snow-line in the uneven hollows of the pre-glacial ridge, where it would become gradually compacted into ice and remain. In the mean time the steep projecting portions would be subject to the action of frost, by which they would be gradually converted into gendarmes, and finally reduced to the level of the surface of the ice in the hollows. After this the ice and the rock bounding it would be reduced at an equal rate, until finally there would be no hollows left in which snow could accumulate, and the *arête* would be reduced to an even grade. If wide enough, this might be uniformly covered with snow, as in the case of portions of the Bernina and Roseg *arêtes* (Pl. II. Fig. 2). It is obvious that this condition is only approximately produced; the even grade in other cases is partly due to the infilling of the depressions by ice, thus raising the surface to an average level. It is this average level which proves so serviceable to the mountaineer, as the hollows are filled up, and he is able in most cases to traverse the gendarmes round their base.

It seems reasonable, therefore, to assume that the special features shown by *arêtes* are the result of local glacial protection.

4. Cirques.

Passing from the ridges to the hollows between them, we find another typical Alpine feature—the Cirque. Cirques may form the upper terminations of definite valleys, or may occur as niches in the hillsides, lying generally about the same level, high up along the flanks of the main valleys of the Alps. It is the latter mode of occurrence which calls

E. J. G., photo.]

FIG. 1.—PLATEAU PROTECTION AND FLANK EROSION, SPITSBERGEN.

E. J. G., photo.]

FIG. 2.—STREAM CUTTING INTO OLD ICE-PROTECTED PLATEAU, BONDASCA VALLEY, PROMONTOGNO.

E. J. G., photo.]

FIG. 1.—A SYMMETRICAL ARÊTE: THE WEISSHORN.

E. J. G., telephoto.]

FIG. 2.—A TYPICAL ARÊTE, SHOWING GENDARME AND ICE-PROTECTION, PIZ ROSEG.

for special mention here. The majority of these cirques appear to be connected with a series of benches representing all that remains of the sides of an old valley floor, the lower portion of which has been overdeepened and destroyed by subsequent denudation. On this view the cirques represent the modified heads of old lateral tributaries draining the sides of an old valley situated at a much higher level than the present ones, at some former inter-glacial or possibly pre-glacial period. At the present day small streams drain these hollows, which are not infrequently occupied by rock-bound tarns, while in the higher portions of the main valleys, especially on the north side of the Alps, many of these are still occupied by ice. Good examples occur on the flanks of many Alpine valleys, as, for instance, on the west side of the Val Mesocco, especially towards its head, or, again, on the south side of the Val Ticino below Airolo. Indeed, they are the rule rather than the exception. These cirques have been frequently described; it will only be necessary here to call attention to one or two special features. Their origin is ascribed by many writers at the present day to ice-erosion, and no doubt the special armchair form and smoothed, glaciated surfaces are directly due to this cause. In considering, however, the general effect of ice, one cannot but feel that, although their superficial form may be due to ice-erosion, their occurrence at the present day is essentially the result of the protective action of ice.

The latest theory regarding the glacial excavation of cirques, and that accepted especially by American writers, is that of W. D. Johnson, usually known as the "Bergschrund hypothesis." As this has been fully described in a recent number of this *Journal*, it is unnecessary to do so here. In the first place, bergschrunds, though characteristic of steep mountain sides, are not so characteristic of corrie glaciers, since these glaciers occupy nearly level floors. In the second place, where bergschrunds do exist, the so-called basal sapping is to a great extent hypothetical and difficult to understand; for, assuming that blocks do fall down the "schrund" and reach the floor, they can only move in the direction in which the ice is moving, *i.e.* forward, not up into the cliff behind. A bergschrund is a fissure formed in the *névé* near the back wall, and not between the rock and the *névé;* it is difficult, therefore, to see how, even if erosion takes place backwards on the rock-face at the bottom of the schrund, it could affect the denudation of the slope above the adhering portion of the *névé* (Pl. IV. Fig. 1). The real interest of the bergschrund hypothesis lies in the fact that it supplies a reasonable theory regarding the formation of corrie lakes situated in rock basins, since it accounts for the constant supply of angular material to overdeepen the upper end of the floor of the basin. Though the effect of basal sapping on the corrie wall above does not appear very clear, it does not affect the general questions we are considering here, namely, the protection afforded to the hillside beneath the ice which occupies the floor of the cirque. On

the contrary, if we assume that the floor of the cirque travels backwards either by means of basal sapping or by the retreat of the corrie wall by general disintegration, it is obvious that the rest of the corrie floor must remain approximately at the same level while this process is going on. The characteristic features of the cirque seen in profile, the steep bounding wall above, the flat floor of the cirque, and the sudden increase of slope below, are all indicative of localized protection. The corrie wall behind has been riven by frost, and has gradually retreated backwards, the valley slope below has been eroded by the stream and by general denuding agents, but through glacial and inter-glacial periods alike, the corrie ledge has been covered by ice which, in inter-glacial times at least, must have been in a nearly motionless state, and must have protected the hillside beneath it from the denudation which was taking place above and below it. Pl. I. Fig. 2 shows the floor of an old compound cirque which was formerly protected by ice, but being now ice-free is being rapidly cut back by water.

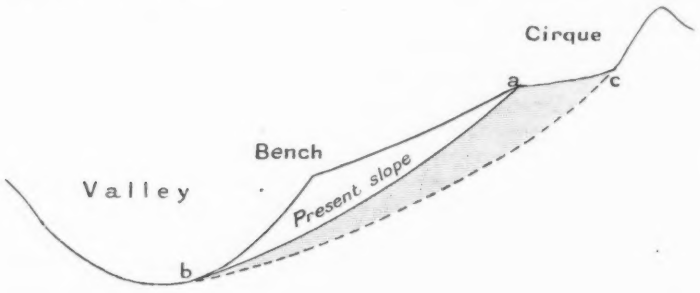


DIAGRAM I

Shaded portion protected by Cirque glacier.

Had the glacier of the cirque not been present, the erosion curve would have started, not from the projecting lip of the cirque, but from the water-parting at the summit of the cirque wall, as shown in Diagram I. The triangular portion above the dotted line has here been preserved, and the cirque, like the *arête*, may be looked upon as a feature which owes its existence essentially to relative protection by ice.

5. Hanging Valleys.

In many of the inner Alpine valleys, as, for instance, those of the Ticino and Reuss, draining the St. Gothard massive, and more especially the valleys draining the south side of the Alps, the chief rivers flow to-day at the bottom of trough-shaped valleys which are generally considered to be the incised or overdeepened portions of older and wider valley floors.

E. J. G., photo.]

BENCHES IN THE CHAMONIX VALLEY, SHOWING SUCCESSIVE STAGES OF OVERDEEPENING.

E. J. G., photo.]

FIG. 1.—THE SCERSCEN GLACIER CIRQUE, SHOWING BERGSCHRUND.

E. J. G., photo.]

FIG. 2.—PIANAZZO BENCH AND HANGING TRIBUTARY, SPLUGEN PASS.

The walls of these troughs are notably steeper than those of the valley slopes immediately above, so that when seen in profile a shoulder or "bench" is noticeable immediately above the level of the overdeepened trough, representing the truncated edge of an older, wider and flatter valley in which the narrower trough valley has been subsequently cut. In some cases three, or possibly four, such benches, one above the other, can be traced, the benches being frequently marked by Alps (Plate III.). The height of any one bench naturally varies from place to place even on the same side of the valley, owing to unequal denudation. Many of the lateral tributary streams draining into a trough valley do not enter at accordant grade, but drop precipitously into the valley, often forming cascades. The mouth of the tributary often coincides roughly in height with fragmentary benches which form the upper edges of the trough (Plate IV. Fig. 2). It is obvious that these "hanging" tributaries have been produced by differential erosion as regards the main valley and its tributaries respectively.

It has usually been considered that differential erosion of this kind has been produced in one of two ways—

1. By the more rapid erosion of the floor of the main valley by river action; *i.e.*, in a non-glaciated country, river erosion may have proceeded at a more rapid rate in the main valley than in those of its tributaries, on account either of difference of hardness of the rocks composing the respective valley floors, or on account of a line of structural weakness coinciding with the direction of the main valley.

2. That when a country is subjected to a period of glaciation, large glaciers will erode more rapidly than small ones, and that, as a consequence, the main valleys containing large glaciers will be overdeepened relative to their tributary valleys; the latter at the end of a glacial period will, therefore, appear as "hanging" valleys.

The second of these theories is the one adopted by Penck, Bruckner, Tarr, Davis, Andrews, and others, to account for the hanging valleys in the Alps, Alaska, New Zealand, etc.

It is quite reasonable to suppose that, other things being equal, a large and deep ice-stream will erode more rapidly than a small and shallow one, and it is quite possible that a trunk stream will erode more rapidly than its tributaries if the whole country be glaciated, on the law of cross-sections as postulated by Penck.* In this way the discordant Alaskan valleys may have been produced as claimed by Tarr and others. It is possible even that the Alpine hanging valleys may owe some of their discordance to this cause.

There is, however, a third possible alternative by which hanging valleys may be produced, which was suggested by the present writer as the result of observations made on the valleys of the Sikhim Himalayas in 1899,† and independently by Kilian.‡ On this view the main *overdeepening*

* Albrecht Penck, *Jour. of Geol.*, Jan.–Feb., 1905.

† E. J. Garwood, *Q.J.G.S.*, vol. **58**.

‡ *Bull. Soc. Geol. de France*, vol. **28**, p. 1003; *La Geographie*, **6**, 1902, p. 17.

of the trough valley did not result from erosion by ice during the glacial period, but from corrasion by running water during the last inter-glacial period, while the present hanging valleys were still occupied to a great extent by ice on account of their greater elevation and protection from insolation. Hanging valleys, then, may be included among the present Alpine features due, in the first instance, essentially to ice protection. It may be well to summarize the reasons which have led the present writer to this conclusion.

In the first place, the glacial period, as a whole, has now been shown by Penck and Brückner to have included four periods of glaciation, which they have named respectively the "Gunz," "Mundel," "Riss," and "Wurm" ice periods; these were separated by three inter-glacial periods. In considering, then, the erosion which took place during the glacial period as a whole, we have to consider that which took place during the inter-glacial periods as well as that which occurred during the glacial periods, a fact which is frequently lost sight of.* The question then arises, what would be the character of the erosion in the main valleys during glacial and inter-glacial periods respectively? In the glacial periods the valleys would be filled with glaciers, while during the succeeding inter-glacial periods these glaciers would retreat up their valleys; rapidly at first from the broader, lower portion, less rapidly when they had retreated further up where the valley would be narrow and more overshadowed by peaks, and where they would be approaching the snow-line. Indeed, it seems probable that they never entirely disappeared from the valley heads before again advancing during the succeeding glacial period. As the glacier retreated the river flowing in the valley below would erode its floor with especial vigour, for, in addition to the general precipitation, it would receive in summer additional supplies from snow and ice melting slowly off the surface of the country, and notably from the retreating main glacier, which besides giving a constant supply in summer, would provide abundant material with which to erode the valley floor. There is every reason therefore for supposing that the river erosion during inter-glacial times would be very considerable, and that a narrow channel, originating first near the end of the glacier in a sub-glacial gorge, would be rapidly developed in the old valley floor; at the same time the sides would be gradually widened by general atmospheric denudation, so that a deep V-shaped valley would result.

Let us turn now to the tributary valleys; these would evidently be affected in different ways. The glaciers in the lower tributaries would retreat first, and rivers would begin to cut down their mouths, as in the case of the main valley, while the tributaries further up the main valley would

* Thus Prof. Davis does not mention the occurrence of interglacial periods in his paper on the Ticino, nor does he appear to realize their importance from the point of view of ice protection, in commenting upon this theory in his recent paper ("Gl. Erosion in N. Wales," *Q.J.G.S.*, vol. **65**, 1909).

still be occupied and largely protected by glaciers. It must be remembered, however, at any given point in the main valley the tributary valleys would, as a rule, retain their glaciers longer than the main valley at that point, as at the present day, first on account of their higher elevation, and secondly, on account of their greater protection from insolation, resulting from their narrow cross section and their proximity to the higher peaks. It follows, further, that the broader tributaries would be freed from ice most rapidly, and their rivers will have the best chance of overdeepening their floors to accordant grade with the main valley in a given time. We should not, therefore, expect all neighbouring tributaries to hang exactly at their mouths. Prof. Davis realizes this consequence of protection, for he remarks that "large or small lateral valleys not occupied to the mouth with side-glaciers, must enter the main valley at accordant level with it, and yet they may be in close neighbourhood with hanging lateral valleys." * In this connection there is another and vitally important point to bear in mind, namely, the amount of insolation received by the different tributary valleys. One of the most noticeable facts connected with the hanging valleys is their irregular arrangement and distribution along the margins of the same trough valley. Thus, some tributary valleys have cut down to accordant grade with the main stream, while others, close by, still "hang" over the main valley; whereas, if the overdeepening of the main valley were due to the glacier which occupied it, it should have left all the tributary valleys hanging symmetrically on both sides. Penck and Brückner also call attention to this discordance of level among tributary valleys, and account for it by supposing that those tributary valleys which were most likely to contain large glaciers are those which now enter at accordant grade. If this supposition be correct we should expect the tributary glaciers facing north and east to have lowered their valley floors the most, so that these valleys would now enter the main valley at accordant grade. The reason for this is clear, for these glaciers would be the first to advance and the last to retreat during a glacial period, and should, therefore, have been able to perform a greater amount of erosive work than those occupying valleys facing south and west.

Now this is exactly what we do not find; it is a striking fact that the typical hanging tributaries are situated frequently only on one side of a valley, namely, on that facing north and east, while those facing in the opposite direction have cut down deep gorges near their mouths and enter the main valley at accordant grade. Even in cases where hanging valleys exist which do not face directly north or east, it will usually be found on studying a map of the district that, although the mouth of the valley may not face in that direction, the general gathering ground on which the snow accumulated to form the *névé* which fed the glaciers *did* face north and

* *Q.J.G.S.*, vol. **65**, p. 312, August, 1909.

east, a fact of very great significance. Amongst many that might be cited the tributaries of the Reuss and Ticino, on either side of the St. Gothard pass, afford good examples. Thus the Faulen Bach, draining the Erstfelder Thal, enters the Reuss opposite Erstfeld over a typical hanging mouth which is well seen from the railway; the valley and its *névé* face north-east. The Maderaner Thal, which enters close by on the opposite side of the Reuss, has cut down its mouth to accordant grade with the main valley, the hanging mouth having retreated to form a step higher up the valley (see section I.);* this valley and its gathering-ground face south-west.

On the south side the hanging valleys cited by Prof. Davis all occur on the right bank of the Ticino, or the side facing north-east, and many other instances, including the Himalayan examples and the Maloja district previously cited by the writer, could be given.† It may, however, be urged that it is a mere assumption that a north-easterly aspect exerted any real influence on the length of time during which glaciers occupied these valleys. We have, however, only to turn to the present distribution of glaciers occupying tributary valleys to see that the contention is thoroughly borne out. The most striking case on a large scale is the Engadine district, though others occur. Here we find a row of large glaciers—the Bondasca, Albigna, Forno, Fedoz, Fex, Roseg, and Morteratsch, the last, the second or third largest in Switzerland, all facing north-north-east, while not a single glacier occurs on the opposite side of the Inn Valley. Again the *névés* draining into the Göschenen Thal and the Piz Blas districts face north-east. In fact, we cannot study a sheet of the Swiss map without, as a rule, observing the same phenomenon. There seems, then, clear evidence that the hanging valleys which now form so conspicuous a feature in glaciated districts owe their origin, in great part, to the protection of the side valleys by ice, while the floor of the main valley was being overdeepened by water.

So far, however, we have only considered the work which appears to have taken place during an inter-glacial period. Let us consider briefly the effect of a returning glacial period. During this period the glaciers, as they advanced down the main valleys, would have at first to accommodate themselves to the narrow overdeepened portion cut by the river during the previous interglacial period. By degrees they would round off and widen, and to some extent deepen this gorge, giving the valley its final trough-like form. It would seem essentially the function of rivers to cut gorges downwards, and of glaciers to occupy wide valleys, unless forced to accommodate themselves to a previously water-cut gorge. This tendency is well seen in the lateral expansion of an Arctic glacier when it reaches a plain or a bay of the sea.

During this glacial advance the sides of the valley would be to some extent undercut, and the steep mouths now characteristic of many of the tributary hanging valleys may very likely be due to this process, which

* For plotting this and other sections on pp. 330 and 331 I am indebted to Mr. H. S. Bion, B.Sc.

† *Q.J.G.S.*, vol. **58**, 1902, p. 710.

increased the height of the mouth above the floor of the main valley and truncated the more gently sloping gorge which they had begun to establish at their mouths by the end of the interglacial period.

The glaciated character of the present trough-shaped valleys does not necessarily show that the trough is entirely, or even chiefly, due to excavation by ice, but that ice has modified a pre-existing inter-glacial valley. The truncated spurs near the bottom of a glaciated valley are frequently cited as proof that the overdeepening of that valley was produced by glacial erosion, but surely their presence shows clearly that a winding river valley must have existed previously, extending nearly to the bottom of the overdeepened portion, or there would have been no spurs in the trough valley to truncate! this is well shown in Ruskin's sketch of the Faido reach of the Ticino valley (Fig. 2). The glacier has, then, widened

FIG. 2.—TRUNCATED SPURS IN THE TICINO VALLEY. AFTER RUSKIN.

a pre-existing river-valley, and the truncation of the bottom of the overlapping spurs appears to prove more conclusively than anything else that a river valley did exist which was subsequently modified by ice; in that case it also shows that the hanging valleys, with the exception of the portions of their mouths which have been subsequently cut back by the widening action of the glacier, were present during the inter-glacial period, and must have then been hanging into the main valley and have been relatively protected. It is obvious that the excavation of the trough valley entirely by ice, during a glacial period, could not have produced hanging valleys on one side and not on the other, nor have limited these in so many cases to the tributaries facing north-east. Again, *what was happening to the country during these inter-glacial periods?* Penck and Brückner admit that the Mündel and Riss interglacial period was twelve times as long as the present post-glacial period. What was happening all that long

time? The erosion which must have taken place during these inter-glacial periods is, apparently, altogether ignored.

The successive developments of an Alpine valley system as here suggested are set forth diagrammatically in Diagram III., in which an attempt has been made to show, by a cross-section of a main valley, the various stages in the evolution of the present drainage system of such a valley as the Ticino or the Reuss.

A represents the valley at the end of, say, the second glacial period; B at the end of the third glacial period; and E the present post-glacial valley. A view of the chief of these features is shown in the photograph of the Chamonix valley (Pl. III.). C indicates the gorge cut by water during the last inter-glacial period, which was gradually widened to the V-shaped valley D towards the close of this period. During the last

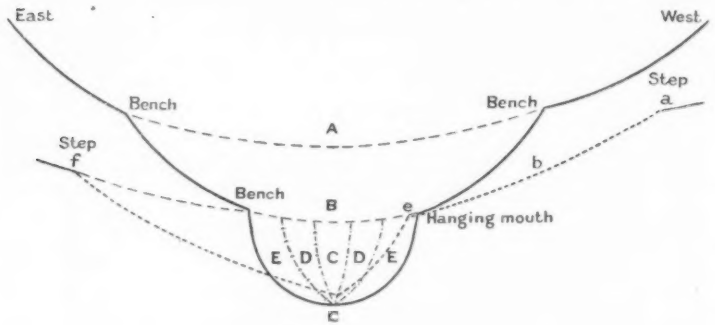


DIAGRAM III

Showing valley development during three glacial and two interglacial periods.

glacial advance this was widened and slightly deepened, to form the present trough-shaped valley E. The degree of adjustment of the lateral tributaries is shown by the dotted lines abe-fEC; a represents a step in the western tributary, above which we have the remains of the floor of the tributary when it drained into A, being protected during the second inter-glacial period, while abe was being cut to accordant grade with B, though it has, no doubt, been gradually lowered subsequently.

During the last interglacial period, while the gorge C was being cut, the valley eb was at first protected by its glacier, but as D developed, and the glacier retreated, the mouth, then hanging into the river gorge, was gradually cut back by its stream to the line eC. The widening of the gorge to E during the last glacial advance removed the gorge by which the tributary had been cut down to accordant grade near its mouth, leaving it now "hanging" directly into the main valley; this tributary valley faces north-east. The tributary fEC, on the opposite side, facing

south-west, where the glacier will have retreated early during the last inter-glacial period, has been able to adjust its grade to the main valley during a longer period, and will thus have lowered its floor beyond the reach of the subsequent glacial widening of the main valley. In this case the hanging mouth has been cut back to f, where it now appears as a step, modified, however, like other portions of the drainage system, by the last glacial advance. On this view, then, it is unnecessary to consider that a hanging tributary is produced by a glacier remaining exactly stationary at its mouth; it may advance or retreat. When advancing and falling into the main valley it is still protecting its mouth, and when retreating it will be followed backwards by a water-cut gorge. If, however, this gorge does not extend far up the tributary, it will be entirely removed by lateral erosion by the main glacier during the last glacial advance. This widening must result from the efforts of the ice to modify the water-cut valley into a shape which will afford least resistance to its free movement. This would take place in the direction of widening the sides and truncating the spurs in the already existing river-valley, not in cutting a narrow trough in the already wide and rounded valley B. The trough valley, indeed, cannot have been cut in the first instance by a glacier, and is in itself a proof of the prior existence of a river-valley.

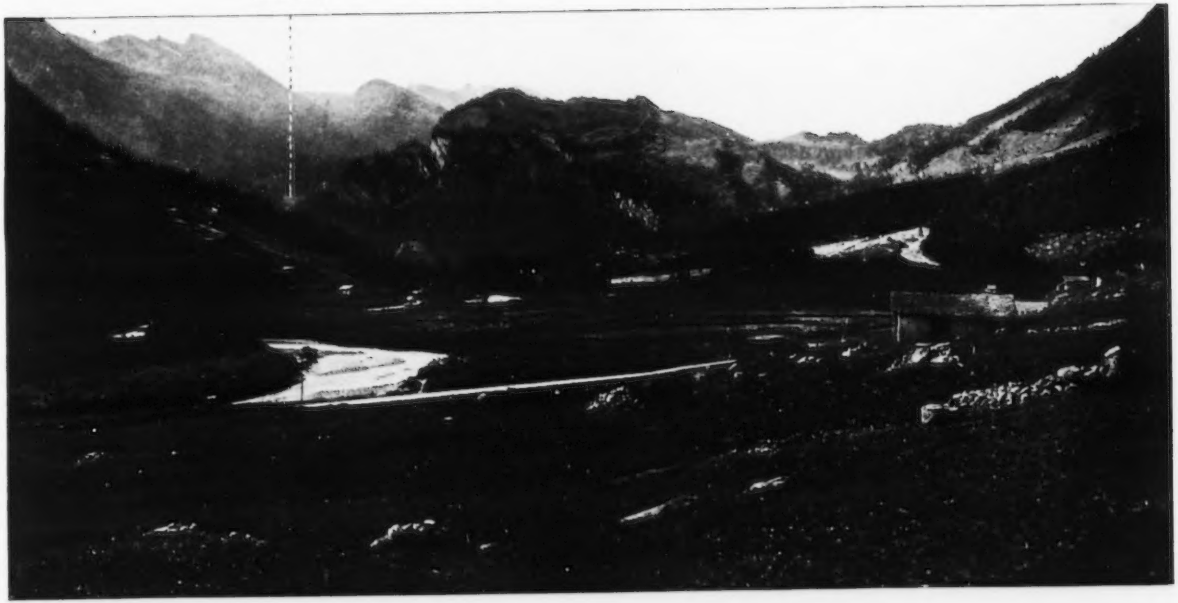
6. The Valley Steps.

So far as our survey of Alpine features has gone, we have only considered the overdeepening of the main valley in connection with the lateral hanging valleys. There remain, however, to be described, other phenomena of the greatest importance, which appear to confirm in a striking manner the conclusions reached above regarding the inter-glacial overdeepening of the main valleys by water erosion, namely, the great steps which so often occur in the floors both of the main valleys and those of their lateral tributaries. Several such steps may occur in the same valley floor, and they appear to be specially developed in many of the valleys draining the south side of the Alps. Although observed by earlier writers, especially Rütimeyer and Heim, they have received but scant attention, and no adequate explanation has been forthcoming, from the advocates of glacial overdeepening.

Rütimeyer and Heim attributed these steps to receding river gorges, cut in the even valley floor previously formed by lateral river erosion. This explanation alone is certainly not adequate to produce the effects observed, and Brückner in criticizing this theory considers that there are two characteristics shown by the steps which are irreconcilable with this view. First, the great breadth of their often wall-like drop, and secondly, the bars which so often crown their edges. He does not, however, explain how these steps could have been produced by glacial erosion, and so leaves us without any theory at all. They do, indeed, appear difficult

of explanation on the glacial erosion hypothesis, since they occur in the same main valleys which, we are told, owe their overdeepening entirely to ice-erosion. How a glacier, while overdeepening the main valley floor, could produce such steps is certainly a question which requires an answer. The modern theory of glacial "plucking," to which so much is attributed by some modern writers, cannot be invoked here. There may be an explanation, but it has not yet been given, and until it is given the glacial overdeepening theory is incomplete. It is the failure of the glacial erosion hypothesis to explain these steps that has led the writer to consider whether glacial protection may not afford a satisfactory solution. One great difficulty arises from the fact that there are no large tributaries entering these main valleys below the steps which could have contained powerfully eroding glaciers capable of undercutting the main valleys, and thus producing the steps as required on the ice-erosion hypothesis. Again, in many places there is no marked change in geological structure as postulated for the smaller inequalities in certain valley floors, while the steepness and height of the steps seem to preclude the possibility of differential glacial erosion.

In order to present the case as clearly as possible it will be best to take actual examples. Of many which occur, the Val Mesocco is, perhaps, the most striking. This valley, a tributary of the Ticino, originates on the St. Bernardino pass, and enters the Ticino valley above Bellinzona. The steps occur as usual in the upper portion of the valley, and are three in number. Section 2 shows a longitudinal section drawn to scale, of the portion of the Val Mesocco where the steps occur. It will be noticed that the steps increase in height as we ascend the valley, the lowest at Mesocco being about 300 feet, that below San Giacomo, 500 feet, while the upper step reaches the enormous height of over 800 feet. This upper step (shown in Plate V.) stretches nearly across the valley, which is here very wide, and forms an abruptly truncated edge to the wide St. Bernardino platform above. This plateau has been divided by streams at its lower end into two depressions separated by a rock ridge, thus forming two parallel steps over which two rivers cascade. The eastern, being the lower and less precipitous of the two, is the route followed by the St. Bernardino road. The western step shown in the accompanying illustration is that over which the Moesa falls, and though hidden away in the cleft it has cut for itself, it is certainly one of the most remarkable cascades in the Alps. The total drop from the incised lip to the level plain of St. Giacomo is 850 feet. The upper portion is a sheer fall while the lower portion occupies a gorge running more or less parallel to the step, and is completely hidden from view. Reference to the Swiss map shows that there is no tributary valley entering the main stream below the step, though a tributary stream does join the Moesa from the hillside on the west, which has evidently cut back the western angle of the step. As the step is certainly not of recent formation, it



E. J. G., photo.]

THE HIGHEST STEP AND THE SAN GIACOMO PLAIN, VAL MESOCCO.

THE LOWEST STEP, VAL MESOCCO, SEEN FROM ABOVE.

must have been traversed by the glacier during the last glacial advance, and must have produced one of the most stupendous ice-falls in the Alps, though it is doubtful whether it was ever seen by man. This step would isolate the portions above and below during retreat, leaving a "dead" glacier on the St. Giacomo plain.

The middle step below St. Giacomo is of smaller proportions, and more gently graded. The valley here is narrower, and the step about 700 feet high, the upper 200 feet, forming a cascade, the surface of the

UPPER FALL OF THE MOESA.

rock being rounded and glaciated by the ice during its last advance. The torrent falls from the western corner as a steep rapid, where it is crossed by the road, and the step stretches over a distance of half a kilometre. Here again there is no lateral valley entering below the step. This step must also date back to a period prior to the last glacial advance.

The step at Mesocco is still lower, being only 300 feet. It has been abandoned by the river, which has cut a gorge on the east side of the valley below the village, and caused the step to recede up-stream. The

THE LOWEST STEP, VAL MESOCCO, SEEN FROM ABOVE.

original step can still be seen to the west of the church, where a small depression occurs, along which the road is carried, and a small stream forms a cascade. A view of this step from above is shown in Plate VI. That this is the original position of the step is shown by the winding course of the river, which has cut round the eastern edge. Rock islands left in other valleys, as at Chiavenna and Bellinzona, may possibly represent similar old steps not yet completely destroyed.

Explanation of the Steps by Glacial Protection.—No adequate explanation of the formation of these steps by glacial erosion has been advanced, and as Heim's theory of water erosion alone appears unsatisfactory, we will turn once more to the protective action of ice, and see whether here also it may not afford a solution.

As suggested above, in considering the origin of the hanging lateral valleys, the main valley would be rapidly overdeepened during the inter-glacial periods by river action augmented by the water flowing from the retreating glacier, both on account of the large volume of water contributed by the glacier, and the ample supply of denuding material of every grade furnished by the glacial *débris*. Another circumstance which may bear in an important way on this question is the possibility of an elevation of the alps having occurred during the last inter-glacial period as the ice-cap melted away. This would result in an increased grade to the valley floor, and a corresponding augmentation in the erosive power of the stream.* On this subject Penck remarks, "There are many reasons for assuming that the Alps were elevated during the great Ice Age, and that this elevation was a true vertical upheaval." † This overdeepening would naturally follow the glacier in its retreat up the valley during the whole inter-glacial period, but could not take place beneath the glacier, which would, therefore, relatively protect its floor, while the sides of the overdeepened valley below were being widened by atmospheric agency. The glacier end would then tend to rest on a raised floor, representing the valley left from the preceding glacial period, and we should thus have produced a hanging step towards the head of the main valley corresponding to the hanging tributary valleys at its sides. This portion of the slope would, therefore, represent approximately the distance to which the glacier retreated during a particular inter-glacial period. The longer the inter-glacial period the further back would this step occur, and the greater would be its relative height above the overdeepened floor. When the glacial conditions returned, and the ice again advanced, it would convert the V-shaped into a U-shaped valley with steep sides; whereas the step produced in the inter-glacial period would be, to a great extent, preserved under the ice as long as it was covered by it. That such was the case is amply shown by the rounded and polished edges of the steps. Indeed, nothing in the Alps testifies to the slight downward erosion

* See Garwood, *op. cit.*

† Penck, *Jour. of Geol.*, January—February, 1905.

produced by its former glaciers more than the preservation of these hanging steps through several glacial maxima. The three steps in the Val Mesocco must, on this view, represent three periods of glacier retreat and inter-glacial overdeepening, and two intervening glacial maxima during which the ice advanced covering and, to a great extent, protecting the step or steps, previously formed.

It is obvious from similar considerations that—of the three steps we are dealing with—the highest must represent the oldest, and have been formed during the first of the inter-glacial periods, though this may not necessarily have been the first true inter-glacial period; the lowest step will then be the newest, formed during the last inter-glacial period. On this hypothesis, the protecting glacier must have retreated furthest during the first inter-glacial period, and the temperature must have risen to the highest point reached during the whole glacial period. During the second inter-glacial period, when the St. Giacomo step was formed, the glacier did not retreat so far, the temperature did not, therefore, reach the

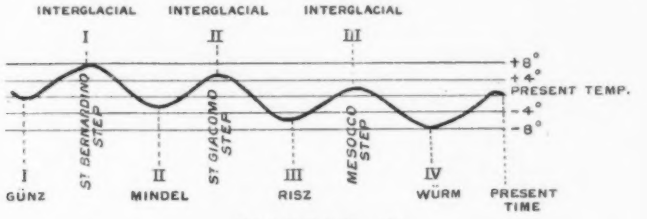


DIAGRAM IV

GLACIAL AND INTERGLACIAL TEMPERATURE CURVE IN RELATION TO THE MESOCCO STEPS.

same height as during the first inter-glacial period. Similarly, in the case of the third Mesocco step, the glacier remained at a still lower level before again advancing, and the highest temperature reached would again fall short of that reached during the second inter-glacial period.

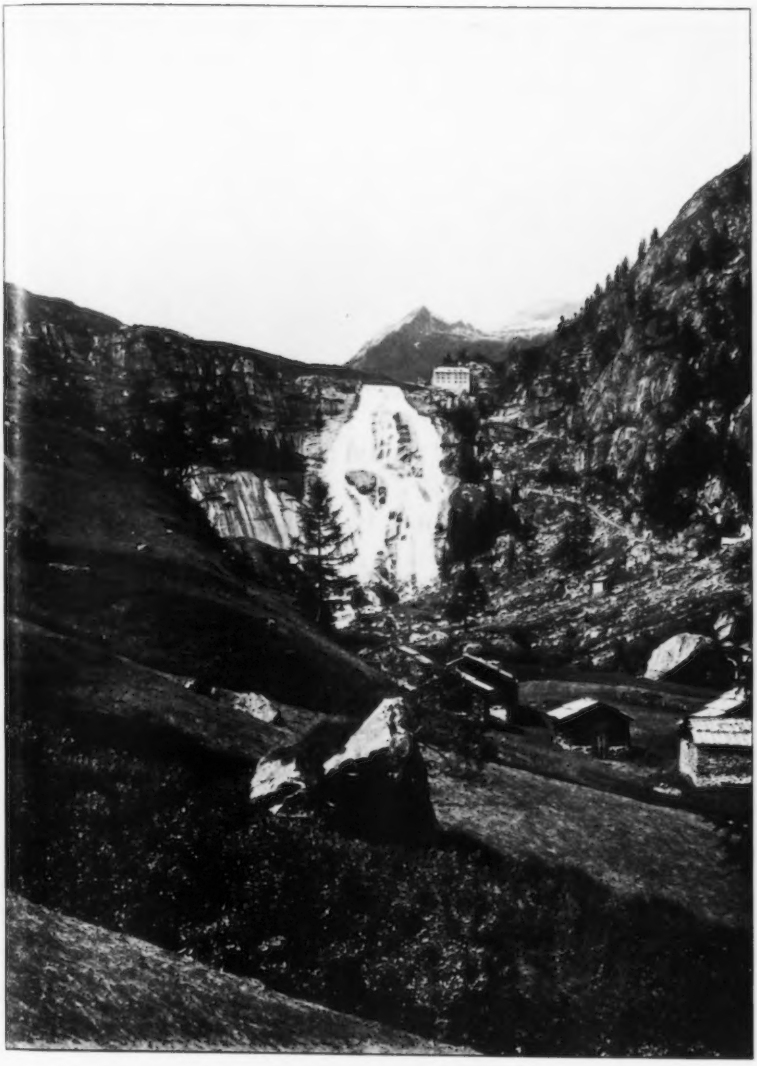
Examples of glaciers, which at the present day still cover and protect one of these steps are not uncommon; the best example is, perhaps, the Rhone glacier, which is only now melting back and uncovering such a step.

It will be interesting now to compare these conclusions with those arrived at regarding the fluctuations of temperature during the glacial and inter-glacial periods. In Diagram IV. is given the temperature curve for four glacial and inter-glacial periods in the Alps, as plotted by Hess,* to which are added the positions where the three Mesocco steps would be formed. A glance at the figure shows at once the remarkable

* Hess, "Der Gletcher."

coincidence between the relative temperatures reached during the several inter-glacial periods, and the relative distances to which the glacier retreated during these periods, *i.e.* the present positions of the steps. Although the Val Mesocco has been taken for illustration, it is well known that similar steps occur in many other valleys, especially on the south side of the Alps. One of the most interesting examples occurs in the upper valley of the Toce, draining into the Val Formazza from the Gries pass. Here the well-known Tosa fall is due to the presence of an important valley step, 470 feet high, shown in Plate VII. No tributary valley enters below this fall. The step occurs in coarse compact gneiss, which also extends some distance below the fall on either side of the valley. Above the step the valley floor has the usual level character, while both above and below the fall other important steps occur.

The series of steps traversed by the Griesbach, between the Gries pass and the Falls of Tosa, are of special interest, as they illustrate, unusually well, one feature which is frequently associated with these valley-steps, namely, the presence of a nearly level alluvial plain immediately above the step. As the lip of the step is formed of solid rock, the alluvial material above must lie in a rock-basin and be retained by the bar of rock forming the edge of the step. The sketch-map (p. 332) shows the arrangement of the steps and alluvial flats along the course of the Griesbach. The lowest flat extends back from the Tosa falls to below Morast, above which we find the next step, Plate VIII. Fig. 2. Above this step occurs another alluvial flat, namely, Bettelmatt, and above this follows the step up to the Gries glacier, which drains down both sides of the pass. It will be noticed that these flats coincide with outcrops of Rauchwacke and Dolomite, and that the valley widens at the flats in the direction of the strike of these rocks. The district, indeed, recalls vividly the Val Piora above Airolo, where similar depressions occur in Rauchwacke and are still occupied by lakes. The Griesbach flats may therefore be regarded as a more advanced stage than the Val Piora lakes, the original lake depressions in the Rauchwacke having been filled up by detritus. Attention is specially called to these features, as it may be reasonably urged that the depressions are due to glacial excavation of the softer rock. It is indeed possible that the weathered and partially dissolved Rauchwacke may have been readily removed by glacial action where it lay in the direct path of the glacier, though it is difficult to see how this could take place to any depth, as the lower layers of the ice would soon become embayed and the motion confined to the upper layers, which would then tend to destroy the lip at the lower end of the depression; it would be interesting, therefore, to know the depth of alluvium accumulated on these flats. The valley receives at least two important tributaries, which fall into the Griesbach over hanging mouths, one on each side of the valley. That entering on the left bank at Kehrbächi Riale, a short distance above the Tosa fall, drains the Val Toggia leading to the



V. Sella, photo.]

THE FALLS OF TOSA, A STEP IN THE VAL FORMAZZA.

E. J. G., photo.]

FIG. 1.—THE STEP ABOVE MORAST, GRIES PASS.

E. J. G., photo.]

FIG. 2.—THE DISGRAZZIA ARÊTE, SHOWING ICE-FREE SOUTHERN SLOPE.

San Giacomo pass, and enters over a steep rock-wall, while that entering from the opposite side near Morast forms a steep hanging mouth excavated in Rauchwacke. The flat plains or rock depressions filled with alluvium are not confined to this district; thus the plain of San Giacomo in the Val Mesocco and the alluvial flat at Gletch, above the lower step in the Rhone valley, are evidently similar cases. These rock depressions with raised lips appear to belong to the "Zungenbecken" of Penck and Brückner, and to represent local depressions eroded by ice, where the glacier maintained itself during a long period approximately in the same position. If this is the case, it bears out strikingly the contention that the steps were covered by ice during the whole of an inter-glacial period, and were relatively protected compared with the valley below.

In addition to the two districts described, there are many others which show a similar association of steps, benches, and hanging valleys, notably the south side of the Splugen pass, which has been overdeepened by river action to form the Cardenello gorge, leaving a conspicuous series of benches at Pianazzo, Cadoja, Palude, etc., over which the lateral tributaries cascade in magnificent waterfalls (Pl. IV. Fig. 2). These benches all occur at heights between 1410 and 1450 metres, and coincide with a lower modified step in the Cardenello gorge. Above this, a higher series of benches occur at about the 1850-metre level, corresponding to the upper edge of the Cardenello step. It is the overdeepening of the valley by this water-gorge which has given such trouble to engineers, and has necessitated the wonderful zigzags along the face of the cliff by which the road climbs up to the Pianazzo bench to obtain a secure footing on the older, gentler slope of valley floor above.

Close by, a little further east, but draining in the opposite direction, we find another very interesting valley, the Averser Rhine, whose chief tributary, the Val di Lei, drains Italian territory. This little valley, one of the few where Romanch is still spoken, affords a splendid object lesson to the student of hanging valleys. The valley is undoubtedly a water-cut gorge, and contains three chief hanging tributaries, of which that from the Val di Lei is the most striking. It also contains several steps, the lowest occurring at its junction with the Hinter Rhine, which here also falls over a similar step. A second step occurs a little further up the Averser Rhine above the bridge. The hanging tributaries, the Starlera and the Lei, although they enter on opposite sides, both descend from gathering grounds which face north-east, and they may reasonably be attributed to ice protection, while the gorge-like Averser valley is evidently water-cut. Further down the Hinter Rhine flows through the Via Mala cleft, a water-cut gorge cut in the old upper valley. The whole system of drainage of the Hinter Rhine, in fact, shows adjustment by water-erosion to the trunk valley at Thusis. While above Thusis, again, in ascending the Albula pass, we find a series of benches and over-deepened water-cut valleys. Lastly, allusion may be made to the steps in the

upper Rhone valley, shown in Section 5. The lower step just below Gletch is steep in its upper portion, but then slopes more gradually to Oberwald. The upper step is that over which the Rhone glacier now falls, and, when fully exposed by the further retreat of the glacier, will be one of the finest steps in the Alps. It is the best example we have at the present day of a glacier-protected step from which the ice is gradually melting back. The geological structure is here more complicated, as a band of Rauchwacke runs through the Furka pass, and is possibly continued under the aluvium to Gletch. The district altogether is a complicated one and requires a chapter to itself. It is possible that the Rhone glacier step ought to be considered, not as a step in the main valley, but as a lateral tributary of the great tectonic valley of the Alps, which may at an earlier period have flowed at a higher level from the Oberalp over the present Furka notch before the Schölenen gorge was cut through the crystalline ridge and the drainage of the Andermatt valley captured by the Reuss; but this is too large a question to discuss here.

Many of the higher steps may still be buried beneath existing glaciers and *névés*, indeed, it seems reasonable to regard the larger ice-falls which occur in many valley glaciers as protected steps dating from previous inter-glacial periods. If the ice were to retreat beyond these, features very like the Mesocco steps would be left.

There seems, then, considerable evidence that the steps in the main valley owe their origin to ice protection during inter-glacial periods; the successive steps marking roughly the points to which the inter-glacial streams were able to cut back while the older valley floor above was still ice covered. The upper step will be the oldest, and will have been covered by ice and preserved ever since its formation, and only recently exposed since the final retreat of the glacial period.

If these conclusions are correct these steps should not be isolated phenomena, but should be closely bound up with other results of river overdeepening and ice protection, thus—

1. The steps should be connected with benches which remain on the sides of the valley below, showing that they represent the upper non-overdeepened portion of an older valley floor, just as the lateral benches are admitted on all hands to be the relics of the sides of the old overdeepened floor.

2. The lower step should be directly related to the present lateral hanging valleys, always making allowance for irregular lateral denudation, and for any glacial erosion which took place above the step during the interglacial period.

3. Under favourable conditions similar steps should also occur at some point in the floor of the lateral tributaries which *have* cut down to accordant grade with the main valley (representing the lowest step in the main valley).

4. Even in the lateral hanging valleys steps might be expected to occur, representing the highest or middle step of the main valley.

5. Lateral benches should sometimes be found in the side valleys below the steps corresponding to them, just as in the case of the main valleys, though, owing to their small size, they would be easily destroyed and difficult to trace.

6. Lastly, under the most favourable conditions these lateral terraces, when found in the side valleys, and traced round into the main valley, should coincide generally with those of the main valley. If all, or even several, of these conditions can be established the protective effects of ice would appear to be fully demonstrated.

Much more detailed evidence, founded on careful mapping in the field, is required before this connected system of steps in the main and tributary valleys can be finally established, but there is very strong suggestion of such connection in valleys like the Val Formazza, the Val Mesocco, and the south side of the Splugen pass. An attempt to show this connection is made in the sections accompanying this paper, where the fragmentary benches occurring about the same height as the steps in the main valley are shown. Irregular denudation, however, due to local causes, will always make a complete restoration impossible. The steps in the tributary valleys, again, must occur at irregular heights according to the distances through which the various streams have cut back their floors subsequent to the retreat of the ice.

The Ticino valley affords rough indications of most of the conditions postulated above which may be briefly summarized.

Hanging valleys occur on the side facing north-east. Steps occur high up in these as well as at their mouths as in the Val Piumogna. Steps occur at the head of the Val Bedretto, while benches in the Val Canaria correspond with those in the main valley.

One of the most suggestive districts is that drained by the upper tributaries of the Val Formazza, the Griesbach, and Toggia, shown in the map (p. 332), which display a remarkable connection between the hanging tributaries and the valley step at Bettelmatt. As shown on the map, the contour immediately below the 2100-metre line passes practically through the lips of the four hanging valleys—the Toggia, Neufelgiubach, Banbach, and Hochsandbach, and the same contour crosses the upper edge of the step below the Bettelmatt plain shown in Plate VIII. Fig. 1. This can scarcely be a mere coincidence.

In concluding this discussion of valley steps, it may be of interest to compare the heights at which some of the steps occur in three of the valleys described above—

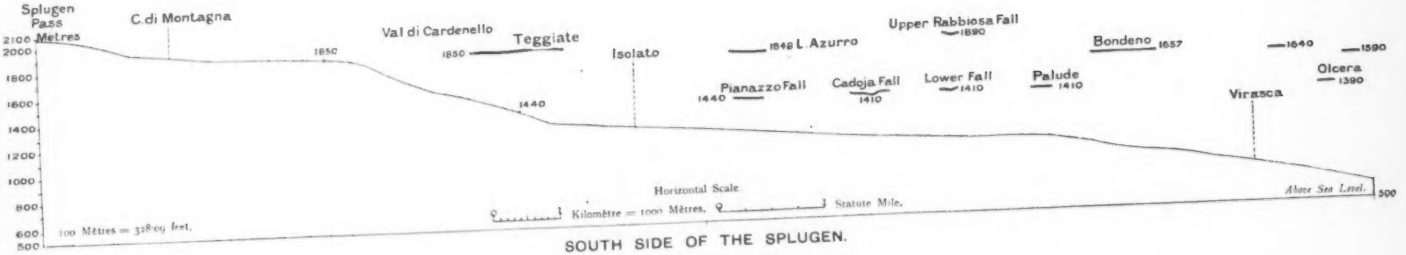
Val Formazza	. Unterfrut step, 1500 metres; Staffelwald step, 1200 metres.
Splugen, S. side	. Pianazzo bench, 1440 metres.
Val Mesocco	. . St. Bernardino step, 1450 metres; St. Giacomo step, 1200 metres.

Without insisting too strongly on the point, it is interesting to note the coincidence in the heights shown. The most striking is certainly the

VAL MESOCCO.

Horizontal and Vertical Scale $\frac{1}{100,000}$

SECTION II.

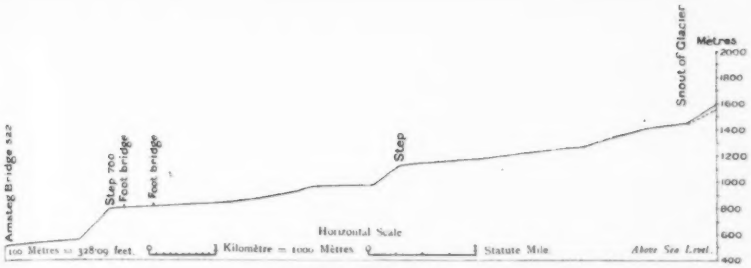


SOUTH SIDE OF THE SPLUGEN.

Horizontal Scale $\frac{1}{100,000}$. Vertical Scale twice exaggerated.

SECTION III.

5 Amateg Bridge 522



MADERANER THAL.

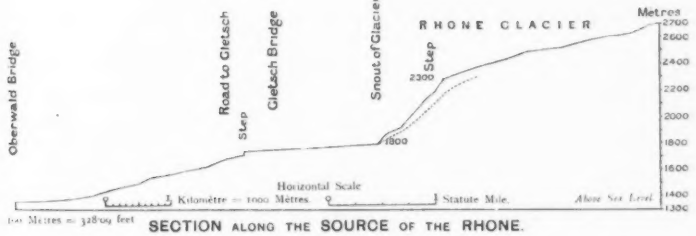
Horizontal Scale $\frac{1}{100,000}$. Vertical Scale twice exaggerated.

SECTION I

VAL FORMAZZA AND TOSA FALL.

Horizontal Scale $\frac{1}{100,000}$. Vertical Scale twice exaggerated.

SECTION IV.

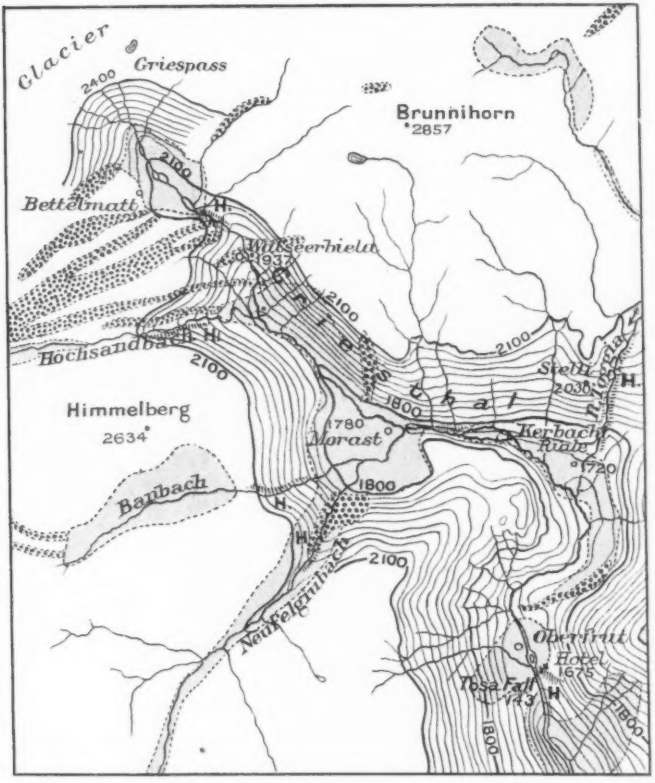


SECTION ALONG THE SOURCE OF THE RHONE.

Horizontal Scale $\frac{1}{100,000}$. Vertical Scale twice exaggerated.

SECTION V.

long alluvial plains above the Staffelwald and St. Giacomo steps, which both start from the 1200-metre level. Attention is drawn to these coincidences chiefly with a view to future work in this direction. Should



THE GRIESTHAL AND FALLS OF TOSA
Heights in Mètres 100 = 328·09 feet.
Contours every 30 Mètres.
Rauchwacke and Dolomite.
Alluvium.
H. Hanging mouth or step
Nat. Scale 1:50,000 or 1 Inch = ·789 Statute Mile.
1 0 1
Statute Miles.

DIAGRAM V.

it be found that any marked general agreement occurs between the heights at which steps occur in different valleys draining the same district and facing in the same direction, it would seem more reasonable

to attribute this agreement to climatic influence, namely the height to which the glaciers retreated during an inter-glacial period rather than to the occurrence of softer beds at the same level in different valleys.

7. The Steep South Side of the Alps.

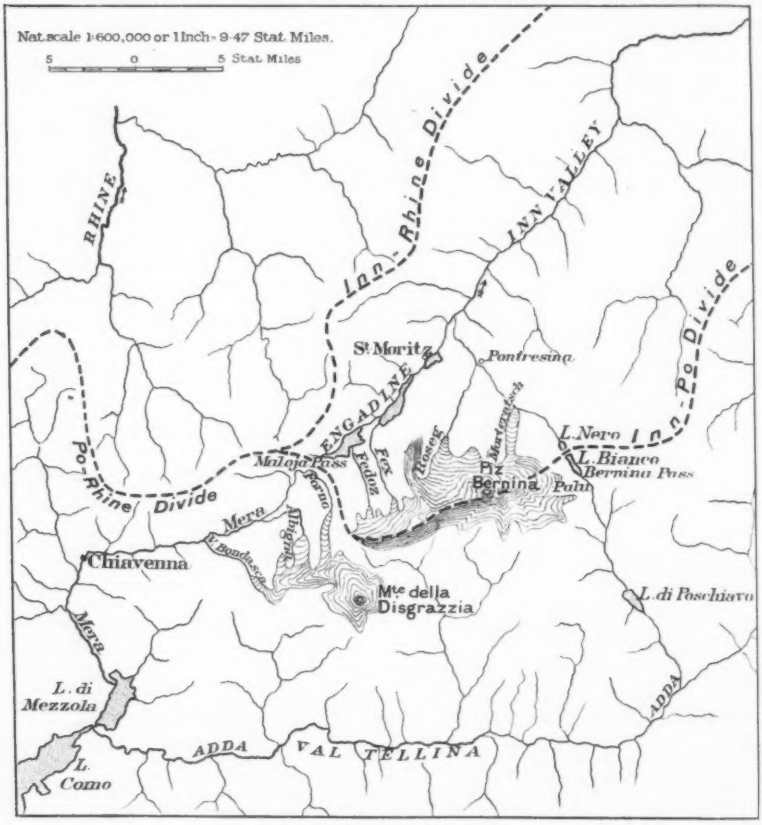
The features which have so far been described are comparatively small and of local occurrence, but there is one broad feature which must strike all travellers crossing the Alps from the north, namely, the rapid character of the descent on the south side.

This marked contrast between the northern and southern slopes is not confined to the main passes, but is also characteristic of many mountain ranges; indeed, it is so universal that some general explanation appears necessary. It is evidently due to the greater effect of denudation on the southern as compared with the northern slopes, but the reason for this accelerated denudation on the south side is not at first apparent. Is it possible that the protective effect of ice, which we have considered above, may also be responsible for the general higher level of the northern slopes, especially in their upper portions? The greater amount of insolation received on the south side is a recognized fact, and the local absence or rarity of *névés* and glaciers on this side is a natural consequence which follows from a more elevated snow-line. If, then, as postulated above, ice is relatively a protective agent, it follows that the upper slopes and valleys on the north side are being protected by snow-fields and glaciers, while on the south side the rivers are eating their way backwards into the water-parting and deepening their valleys, while rain and frost are loosening the unprotected surface. If this is true of the present time, it must have been equally true of previous inter-glacial periods, so that the present contrast of the northern and southern slopes is the cumulative effect of these processes during the whole of the glacial period.

The conditions above described are well seen in the photograph of the Forno District, taken from the Disgrazzia *arête* (Plate VIII. Fig. 2), where we see the *névés* of the Forno and Albigna glaciers descending on the right of the picture; while on the left we find a nearly snow-free slope, the edge of which plunges steeply into the Val Masino below.

The whole district, indeed, drained by the headwaters of the Adda and the Inn, affords an admirable instance of the manner in which the tributaries of the Po, on the south side of the Bernina chain, have cut and are cutting their way back into the Inn drainage basin; not only are the lateral tributaries of the Val Masino and the Val Malenco creeping back into the southern slopes, but the sources of the Inn drainage itself are being attacked and captured at both ends of the upper Engadine, namely, the Maloja on the west and the Bernina pass on the east, leaving the two chief sources of the upper Inn abruptly truncated at their heads. A glance at the accompanying sketch-map of the district (Diagram VI.) shows that the

robber is in both cases a tributary of the Adda. At the west end the Maloja is being captured by the Mera, which has taken advantage of a joint and cut a nearly invisible gorge back into the south corner of the pass. By this means it has captured the drainage from the Forno glacier, while another feeder is working backwards along a similar joint in the



SKETCH MAP OF THE
INN-ADDA DRAINAGE.
DIAGRAM VI.

north corner of the Maloja wall, and is capturing the drainage from the Lunghino lake, situated well in the Engadine drainage area.

There can be no reasonable doubt that, just as the drainage from the Forno glacier has been and is still being captured by the headwaters of the Mera, so in like manner the drainage from the Albig a and neighbouring

E. J. G., photo.]

FIG. 1.—THE STEEP SOUTH SIDE OF MONTE ROSA.

E. J. G., photo.]

FIG. 2.—THE HANGING ALBIGNA VALLEY BELOW THE MALOJA.

valleys, which now flow into the Adda, once flowed eastward into the Engadine, tributary after tributary having been captured by the Mera as it extended its headwaters backwards during successive interglacial periods. This conclusion is borne out, not only by the trend of these captured valleys, but also by the present fish-hook courses of the captured streams, a feature so eminently characteristic of stolen drainage. The overdeepening of the Mera valley is then essentially due to river erosion. The Albigna drainage is therefore of peculiar interest, since it forms a hanging valley 1200 feet above the level of the Mera, providing a case where it appears impossible to apply the theory of glacial overdeepening, but one which can only be explained by river erosion and glacial protection.

The excavation of the head of the valley as far as the wall of the Maloja, above the junction of the Albigna torrent with the Mera, must have required an immense time, and bears witness to the long period during which the Albigna valley must have been protected by the glacier which still fills its valley, though now in retreat. There is no doubt that ice, both from the Albigna valley and possibly from the Maloja also, during the last glacial advance, flowed down the Val Breggalia, modifying the older river-valley; but the suggestion that the original overdeepening which reversed the Albigna drainage and left it hanging in mid-air, was performed by an overflow of ice from the Engadine glaciers, is not to be entertained for a moment. It is only necessary to point out that no ice could possibly overflow from the Engadine into the Mera valley until the Albigna drainage had been captured, to show into what an *impasse* the theory of glacial excavation as applied to the hanging valley of the Albigna at once leads us. Although the Albigna glacier, like all others in the district, is now retiring, it cannot be so long since it overflowed the lip and poured down into the Mera valley. The photograph reproduced in Plate IX. Fig. 2 shows how the older gorge which was cut back in the face of the cliff, has been modified by the ice which lately poured over it, while a new water gorge is again being cut in this modified face. Above the lip and below the present snout of the glacier an alluvial flat has been laid down in all respects similar to the flats connected with the valley steps described above.

The case of the Albigna-Maloja drainage is given here at the risk of slight repetition on account of its extremely instructive character, linking as it does the formation of one of the finest hanging valleys in the Alps with the encroachment of the rivers draining the ice-free southern slopes, thus showing the close connection between the two phenomena.

But the encroachment of the Po drainage on that of the Inn is not limited to the action of the Mera; another tributary of the Adda, draining the Poschiavo valley, has encroached in an exactly similar manner on the Inn drainage at the other end of the upper Engadine, and truncated the headwaters of the Bernina, so that as we ascend the

Bernina pass from Pontresina we find the head of this wide open valley suddenly ending in mid-air, recalling the exactly similar phenomenon met with on reaching the Maloja pass from St. Moritz. The analogy is in every way complete, for not only is the drainage at the head reversed in both cases, but lakes have been formed by deltas thrown by tributary streams across the flat floor of the beheaded valleys, which, having lost their headwaters, are no longer able to remove the deposit. Thus the water-parting of Europe, between the basins of the Po and the Danube, now consists, on the east, merely of a small ridge of moraine and delta material separating Lago Nero from Lago Bianco, while at the west end the lake of Sils, dammed by the delta from the Fex valley, will, if left undisturbed, soon be captured by the Mera, and its waters diverted westward to swell the volume of the Po. Many other instances of the contrast between the northern and southern slopes of the Alps might be given. The most striking case is presented by the two sides of Monte Rosa, the south side, as shown in Plate IX. Fig. 1, plunging precipitously down into the Macugnaga valley, while the northern side, covered by vast snowfields and glaciers, slopes gradually into the Zermatt valley; so that, whereas the ascent of the north side was one of the first to be made among the higher peaks, the ascent from the south side was one of the latest, and was only accomplished after several attempts had ended fatally.

8. Conclusion.

The foregoing account is an attempt to show how certain features in the Alps may have arisen on the assumption that ice erodes less rapidly than other denuding agents, and may consequently be protective. It is, of course, possible that under certain other conditions ice may erode more vigorously than water; if so, then the results would naturally be reversed. Can it be possible that we meet with both these conditions even in the same district, perhaps even in the same valley? Can it be that in the higher valleys and slopes, ice has exerted a relatively protective influence, while in the lower portions of the valleys where many large affluents coalesced in a single valley, glacial excavation has been more vigorous. If this should be so, it will explain the different interpretations which different observers have placed on the facts they have observed. Further detailed observations alone will show.

The President (before the paper): The subject of to-night's lecture is the erosive action of glaciers, and it is a question on which our lecturer, Prof. Garwood of the University of London, is especially qualified to speak. He has made a most careful study of the Alps, and knows almost all Switzerland, both from the point of view of the Alpine explorer and from the point of view of the geologist. He has also travelled with Sir Martin Conway in Spitsbergen and with Mr. Freshfield on the slopes of Kinchinjunga, where he has had opportunities of watching glaciers under various meteorological conditions. There can be no doubt that glaciers both produce a certain effect in erosion, and also tend to protect the rock under them from the effect

of water and of weather; and there appears to be two schools of thinkers on these subjects—those who lay most stress on the erosive action of glaciers, and those who lay most stress on their protective effects. The lecture to-night will be specially interesting as touching on this vexed question.

Prof. L. W. Lyde (after the paper): I am very glad to have an opportunity of expressing my very strong admiration of the way in which my colleague, Prof. Garwood, works. He could not have taken a better subject to show how really scientific his mind and work are; he goes step by step observing, verifying, testing on the spot, year after year, so that no fact is used until it is absolutely proven, and I only wish I had his knowledge, so that I could say whether certain things are on the edge or under the edge of a certain piece of ice. On the other hand, there are one or two general principles of which perhaps I might remind you in case they help in any way. In the first place, the total amount of work done by the precipitation over any given area, from source to sea, in the long run seems to be approximately the same, whatever form the particular precipitation takes subsequently; and in this case neither water nor ice in itself is very destructive. Indeed, it is almost true to say they are most destructive when least active, ice at the moment of its formation, and water when gently percolating. If the ice and the water in themselves do very little destructive work, the enormous amount of destructive work done must depend upon what they carry with them; and therefore whichever medium carries its material the more violently, should prove to be the more destructive—in other words, ice is relatively a protection. Again, the superficial geology of an area is most stable when its surface is compact and kept at a uniform temperature. Can anything be kept more compact or more uniform in temperature than land which is hermetically sealed by ice? Further, the general principle of protection is accepted by all about other sorts of material; nobody doubts that a cap of sand or a sheet of lava protects what is underneath it from weathering. Why doubt a sheet of ice, and who does doubt it? Who first started the hesitations about it? Not anybody like my friend Prof. Garwood and Mr. Freshfield, but gentlemen who actually boast that they are students rather than climbers of mountains. I should have thought here was a point where the climbing makes all the difference. You may be an admirable student and yet not know whether those stones are under the edge or on the edge of the glacier. Is it not much better that you should be, as Prof. Garwood, both a climber and a student?

Mr. Douglas Freshfield: I am glad to be able to be present here to-night and to take part in the discussion on the interesting problems raised in my friend Prof. Garwood's paper. I am the more glad, because as far as our Society is concerned, I believe, their discussion was begun by me twenty-two years ago in an article published in our *Proceedings* for June, 1888, under the title of "The Conservative Action of Ice." Its aim was to adduce arguments, based largely on my own experience of mountain facts, for the conclusion that (I quote textually) "glaciation is relatively a check to valley formation." It was a humble endeavour to support the position of the geologists who at that date were fighting against Tyndall's and Ramsay's assertions that ice was "the paramount influence in the sculpture of the Alps" and of lake basins.

This controversy is no new one. Want of time has prevented Prof. Garwood, and will prevent me, from referring in any detail to its earlier phases. Against Tyndall and Ramsay were ranged Sir Roderick Murchison, our President, and the fathers of the Alpine Club, John Ball, Wm. Mathews, Nichols, E. Whymper (in whose 'Scrambles in the Alps' glacial problems are very carefully discussed), and one whom we regret is not here to-night, Prof. Bonney, the President this year

of the British Association. We may hope, I think, that at Sheffield he will not miss the opportunity to express *ex cathedrâ* views on our subject, which will come with peculiar force from one equally eminent as a mountaineer and a man of science.

Twenty years ago the contest seemed nearly won for those who asserted that the erosive powers of running water and air combined were greater than those of moving ice. But latterly there has been a recrudescence, principally in Germany and America, led by Prof. Penck and our late guest, Prof. Davis, of Harvard, of the opposite opinion. It is well, therefore, that a leading member of the Geological Society and the Alpine Club, such as Prof. Garwood, should have come here to uphold and illustrate the view held by the majority of those who know mountains best in this country. The subject is one, no doubt, somewhat difficult, even with the aid of beautiful photographs, to make alive to a general audience. But Prof. Garwood has, I think, made most of his main points clear. And I am sure you will agree with me that we owe him our thanks for having succeeded so well in avoiding the jargon of new technical terms, compounded of bad Latin and worse Greek, in which too many modern geologists do their best to conceal their meaning from the ordinary listener or reader.

Prof. Garwood, I note, has adopted a defensive rather than an aggressive attitude. He has been content to ask you to listen to his hypothesis and to consider how far it meets the local facts. He might, and I might—did time allow—go on to show that the alternative hypothesis, that of the greater destructiveness of moving ice, does not meet the local facts.

In my experience and to the best of my judgment, it is in direct contradiction to them, whether in Scotland, in the Alps, the Pyrenees, the Caucasus, or the Eastern Himalaya. The mountaineer with his eyes open can see where the sculptors, air and water, have been able to work in past times, and where the ice-cap has interfered with their operations. Above a certain level he finds shallower valleys and smoother slopes, below it deep-cut gorges and sheltered hillsides. Nowhere is the transition more abrupt and marked than in the Sikhim Himalaya. I cannot here adduce more examples. But there is one matter, mainly of expression, I want to allude to. Prof. Garwood very rightly pointed out that our school is misrepresented when it is asserted that we deny any destructive action by ice. We hold that the question is one of *relative* power. I agree with him in substance, but I should prefer to express myself by a different verb. I would say that while water *erodes*, digs out, ice *abrades*, rubs off. The difference in action seems to me to deserve a distinction in terms. The glacier, with the stones in it, grates along and rubs down and scratches its bed as nailed boots do a flight of steps. Water first cuts, like a knife, a deep gash, then makes transverse gashes, loosens whole hillsides, finally turns a dale into a defile.

I would specially ask my hearers to attend to two points in Prof. Garwood's discourse, when they read it in our *Journal*. First, his explanation of main-valley steps as the result of interglacial periods: this is new to me, and I believe to geologists, and seems on first acquaintance very captivating.

Next, his explanation of the absence of discordance—that is, of a sudden drop in level at the mouth—between the tributary glens dropping into Val Leventina from the north-east (and therefore facing south-west or sunwards) and the main valley by the earlier melting and disappearance of their protective glaciers.

Here I must stop. But as a last word I would ask you not to be content with following the controversy in your studies—where one professor is as convincing, or nearly so, as another. Go to the mountains and see with your own eyes what ice and water have done, and are doing at this moment. If your eyes agree with mine, you will not stand in need of any further evidence. I was brought up to

believe in the excavating powers of ice, and it is mainly "ambulando" that I have been led to a different solution of this hard-fought controversy.

The PRESIDENT: The subject of our discussion to-night has been the effect of covering the surface of the ground with ice. The slow geological changes which take place in these circumstances must depend on a large number of factors —on the hardness of the rock; on the slope and direction of the valleys; and on various meteorological conditions; and the problems involved are therefore of extraordinary difficulty. It is not to be wondered at that many questions thus presented have not yet been solved. I am sure most of us who are not experts have felt quite convinced by Prof. Garwood's eloquent presentment of his case. It is, however, fair to remember that we are somewhat like the jury who has heard three or four able advocates on one side and nobody at all on the other. In any case, we all must hope this discussion will be continued until the parties involved in it arrive at a satisfactory conclusion on these difficult problems.

A SECTION ALONG THE RAILWAY FROM CAPE TOWN TO THE VICTORIA FALLS.*

By A. H. WALLIS, F.R.G.S., Acting Resident Engineer, Cape Government Railways, Mafeking.

IN submitting to the Royal Geographical Society a section along the railway, the writer is of opinion that this is the first complete section of the route that has ever been prepared along the southern part of the continent, and it is hoped that the data will prove of interest to geographers and geologists.

In order to show exactly what value attaches to the information furnished, the following particulars are given:—

The section is plotted to an exaggerated scale, the horizontal scale being 20 miles per inch, whilst the vertical scale is 500 feet to the inch. The vertical ordinates are plotted to each mile of railway, involving the plotting of 1640 vertical ordinates. The data are obtained from the official records of the Cape Government Railways and the Rhodesia Railways, Limited. The levels were taken with an ordinary "dumpy" level, from low-water level ordinary spring tide at Cape Town, with a permitted variation of 0·03 foot per mile. The permission of the Cape Government Railways and that of the Rhodesian Railways, Limited, have been duly obtained for the purpose of this paper.

The section has been carefully plotted. Scaling from the vertical ordinates may be safely accepted as exact to within 10 feet. To those unacquainted with the effects of the exaggerated scale, a warning should be given not to conclude that the continent of Africa, south of the Zambezi, is serrated to the extent as shown on the section; for were the horizontal scale plotted to the same scale as the vertical, the section would of necessity be several hundred yards in length to ensure the surface levels being seen in their true position. The surface levels of the section give their true geocentric position, in as far as sea-level has been assumed as uniformly geocentric. The datum is shown on the section as a straight line. It should more properly be shown on the section as a curve forming an arc of the circumference of the Earth; but it has been shown rectilinearly merely for the purpose of convenience, and the numerical data giving the heights of the

* Sectional Diagram, p. 380.

various places are given as above sea-level in every instance. The levels were taken, as stated before, with an ordinary dumpy level, no coefficient for correction of curvature being adopted.

Since the observations taken do not extend over more than 5 chains in each direction from the instrument, resulting in an observation of 10 chain lengths of true level, in which observation the collimation line of each was naturally tangential to the surface of the Earth, it is clear that each series of observations automatically corrected itself for curvature, inasmuch as each additional collimation line was tangential to the curvature of the Earth. As stated before, a limit error of 0·03 foot per mile was allowed. This error is naturally non-cumulative, the errors of plus being assumed to cancel the errors of minus, as equal sights were taken at equal distances from the position of the instrument. It must be admitted, in response to a possible query, that these levels have not been "tied in" with sea-level at its northern point.

The direction of the railway is shown on the accompanying map by a broad red line, and the figures given in red denote the mileage from Cape Town. The railway, being of necessity a pioneer line, does not run in a straight line from Cape Town to Victoria falls, between which points there is a distance approximately of 16 degrees of latitude, or 1112 geographical miles, but meanders to such an extent as to give the distance along the railway as 1640 statute miles. Again, it must not be concluded that between Cape Town and Beaufort West (339 miles) the section given is a true outline of the country, since naturally a railway has to develop for gradient, avoiding the highest points and crossing ranges of mountains on the lowest and most accessible positions. This will account for the absence on the plan of Table mountain, 3550 feet in altitude, the range of mountains at the Paarl (36 miles), south of Worcester (85 miles), the Hex river mountains at 145 miles, and further ranges at 186 miles, 230 miles, and 270 miles, at which points probably there are peaks towering as high as nearly 7000 feet; but at the same time the section is of value, as it gives an idea of the wrinkling up of the Earth's surface in the manner referred to later in this paper.

Geographers may be assured that from Frazerburg road (290 miles from Cape Town) the section is fairly typical of the country as far as Kimberley (647 miles), although in the stretch of country referred to there are mountains east and west of the railway, reaching a height of probably 5000 or 6000 feet. From Kimberley to the Victoria falls, the railway can be safely assumed as strictly typical of the surface of the country, it being a pioneer surface line in which banks and cuttings have been studiously avoided, thus making the railway section show a true section of the country. It may be here pointed out that the railway between Francistown (1234 miles) and Bulawayo (1360 miles) practically runs upon the watershed of the country.

To commence with the section. It will be seen that Cape Town is the zero line of the railway, rail level of which is 10 feet above low-water ordinary spring tide. Cape Town is situated at the foot, and on the northern side of Table mountain, whose altitude is generally considered at 3550 feet. From zero the railway rises steadily to 650 feet at a distance of 27 miles from Cape Town, after which it falls on its way past Paarl (35 miles) and Wellington (45 miles) to 200 feet above sea-level at 63 miles' distance from Cape Town. It then rises at 85 miles to about 850 feet above sea-level, dropping to 720 feet at 98 miles, where the Breede river is crossed. From Cape Town to 116 miles the railway altitude lies below 1000 feet, but after this point the Hex river mountain climb is commenced, and by the time 145 miles' distance is reached the railway attains an altitude of 3160 feet.

It may here be mentioned, to prevent repetition, that the mileages given in this paper are the distances throughout from Cape Town.

From 145 miles to 160 miles the railway drops once more to 2530 feet into the valley of the Touws river, after which it rises again at Pietermeintjes to 3600 feet, an altitude which it does not attain again for 150 miles northwards. The line drops on its way past Matjesfontein to Laingsburg, where it crosses the Buffels river at 213¼ miles at an altitude of 2140 feet, rising to an altitude of 2720 feet at about 230 miles, from whence it again drops to the valley of the Blood river to 1650 feet at 253 miles, and a few miles further on, to 1560 feet, where it crosses the Dwyka river, rising again at 270 miles to 2300 feet, and falling again to 1760 feet at about 287 miles, where it runs along the valley of the Gamka river near Frazerburg road, from which point it steadily follows the Gamka river as far as Beaufort West (339 miles) to an altitude of 2840 feet. From Matjesfontien (194¾ miles) to Beaufort West (339 miles) the railway passes through the desert country known as the "Lower Karoo," the name given to it by the trek farmers of earlier days. The term evidently is of Hottentot etymology, and means dry or barren. A reference to the section shows that this part of the country lies below 3000 feet above sea-level.

The chains of mountains which lie parallel to the southern coast are exemplified in a small degree by the zigzags of the section at 30 miles, 145 miles, and 186 miles, but in other parts of the colony tower to heights of 8000 feet above the sea. From Beaufort West the country rises to a height of 4550 feet at 405 miles. We are now in the "Upper Karoo," known to the old trek farmers as the "Nieuw Veldt," which maintains an altitude of over 4000 feet for over 100 miles, where it drops into the valley of the Brak river at 505 miles at an altitude of 3980 feet. It must not, however, be assumed that this is the only river between 400 miles and 500 miles, as a fairly large number of streams run from east to west in this distance, all of which, however, empty themselves into the Brak river, which eventually debouches into the Orange river, and which runs westward into the Atlantic ocean.

From 504 miles to 516 miles the railway reaches an altitude of 4370 feet, constituting the southern point of the valley proper of the Orange river, whilst the northern border of the river-bed is crossed at about 600 miles at an altitude of 4030 feet. The country falls from this point to 570 miles to an altitude of 3520 feet, where the Orange river is crossed. The Upper Karoo from 400 miles to Kimberley (647 miles) is characterized by large flat-topped hills. These flat tops are composed of huge sheets of dolerite superimposed upon clay shale beds. These dolerite sheets are attributed to enormous extrusions of molten igneous rock, which, under volcanic pressure, have followed the lines of least resistance into the level bedding planes of the more recent shales and slates. The dolerite sheets act as a covering to the clay shales and retard the work of denudation.

It is no uncommon sight to see a chain of flat-topped hills several miles distant from a similar chain bearing a surface incline almost in a direct line with each other, leaving it conclusively proved that the intervening country was at one time connected and covered with the selfsame sheet of dolerite, but which in the course of time has been washed away.

From 600 miles to nearly 700 miles the surface of the country lies in the vicinity of 4000 feet, falling only below this level at the various beds of the rivers which the railway crosses, such as the Modder river at 623 miles, which runs westward into the Orange, and the Vaal river, which is crossed by the railway at 693 miles at an altitude of 3900 feet. From 780 onwards to 920 miles the country rises well above 4000 feet, reaching an altitude at 810 miles of 4500 feet, passing the

township of Mafeking at 870 miles at an altitude of just under 4200 feet. This strip (from 780 miles to 920 miles) is grass country with little or no growth of trees. Generally speaking, it is of limestone formation with huge underlying beds of dolomite or magnesic limestone.

The railway leaves the Cape Colony at 886 miles 39 chains, where it crosses the Ramathlabama spruit at an altitude of 4180 feet, and enters the Bechuanaland Protectorate. The railway traverses the protectorate fron 886 miles 39 chains to 1289 miles. The major portion of the country passed through belongs to Chief Khama of the Bamangwato tribe, who owns by far the largest portion of the Bechuanaland Protectorate.

From 920 miles to 980 miles the country falls from 4000 feet to 3100 feet, where the railway crosses the Metsimaclaba river, a stream which runs eastward, eventually entering the Notwani, which in its turn becomes the Limpopo or Crocodile river, and which runs eastward to the Indian ocean. From 920 miles to 1270 miles the country lies well below 4000 feet, and can generally be said to be at an average of 3000 feet, dropping below that height only at one or two river-beds, and never rising above 3600 feet in the whole distance. The principal rivers crossed are the Lotsani at 1133 miles, the Shashi at 1218 miles, and the Tati at 1233 miles, all of which run eastward. These rivers are tributaries of the Limpopo or Crocodile river. The country from 990 miles to the Shashi (1218 miles) constitutes the western fringe of the Kalahari desert. The surface is composed mainly of fine red sand, covered in the wet season by a luxurious vegetation, whilst in the dry season it presents the appearance of a typical desert.

From 1270 miles the country rises from 4000 feet to an altitude (at 1300 miles) of 4850 feet, the railway taking its course through the watershed of the country in order to avoid the unnecessary construction of bridges, and it runs between and almost parallel to the Inchwe and Ramaquabane rivers, which are tributaries of the Shashi. The railway reaches Bulawayo at 1360 miles at an altitude of 4464 feet. The country in this vicinity is of granitic nature. From Bulawayo on its course to the falls it drops quickly to an altitude of 4000 feet at 1378 miles, falling to 3900 feet at 1400 miles, and from thence to 3450 feet at 1420 miles, where it crosses the Umgusa river, dropping still further to 3250 feet at 1449 miles, where it crosses the Guaai river, which runs northwards, eventually emptying itself into the Zambezi. In this vicinity the railway passes through a large extent of teak forest. After leaving the Guaai the railway runs straight without any curvature for a distance of 70 miles, and with little or no change of level. At 1500 miles the altitude is 3420 feet. The country is characterized by its sandy desert appearance with many pans or pools of water, showing traces of the remains of an inland sea. At 1520 miles the country rises to 3600 feet, from which point it drops down to Wankie at 1577 miles, to an altitude of 2300 feet, which is the lowest point on the railway between Bulawayo and the Victoria falls. It rises again at 1590 miles to barely 3000 feet, dropping to 2650 and 2780 altitudes, where it passes two unimportant rivers, rising again to an altitude of 3490 feet at 1627 miles, from whence it descends to the Victoria falls (1640 miles) at an altitude of 2099 feet.

The top water-level of the Zambezi river at this point is about 400 feet below rail-level, or 2600 feet above the sea.

A detailed analysis is given of the water taken from a well in the clay slate deposits at Palapye road, one of the lowest points on the railway, as follows :—

	All grains per gallon.
Silica	2·94
Iron and alumina	0·59

All grains per gallon.

Calcium oxide	14·81	equal to 26·45 as calcium carbonate.
Magnesia	12·13	equal to 25·47 as magnesium carbonate.
Sulphuric oxide (SO)	6·65	
Chlorine as sodium chlorine ...	114·07	

All along the railway between the distances referred to we have large tracts of country known as the black mud country.

The writer is in touch with several officers of the Bechuanaland Protectorate Native Police, whose duties carry them throughout the protectorate. These gentlemen are now provided with aneroids and prismatic compasses, and it is hoped that within a few years we shall have approximate data before us to more definitely establish the boundaries of what has been conjectured to be one of the biggest inland sheets of water of a similar nature to Lakes Nyasa, Tanganyika, and Bangweolo.

REVIEWS.

EUROPE.

'HIGHWAYS and Byways in Buckinghamshire.' By Clement Shorter. (London: Macmillan. 1910. Pp. xix., 344. *Map and Illustrations.* 6*s.*) The author's name should be sufficient guarantee that the literary reputation of the series is maintained in this volume. As studies of the subjects which, as it were, wait upon topography these books are excellent. From his descriptions of churches one would judge the present author to be attracted rather by genealogy than by architecture. The most striking structural features of some noted churches (Wing, for example) are missed. But the illustrations in great part supply them.

'Sicilian Ways and Days.' By Louise Caico. (London: Long. 1910. Pp. 279. *Illustrations.* 12*s.* 6*d.*) The small town of Montedoro, which was the headquarters of the writer of this book, is in the inland province of Caltanisetta, a district which has attracted few visitors. On the working of the sulphur mines she has an interesting if somewhat melancholy chapter, and out of her intimacy with native customs she has written much that is of value. But the book contains a good many pages of rather trivial detail.

'A Corner of Spain.' By Walter Wood. (London: Nash. 1910. Pp. xii., 203. *Map and Illustrations.* 5*s.*) The corner in question is Galicia. The book is a well-written general description, which "does not pretend to be a history or a complete record," but is worth the attention of an intending visitor, and is fairly illustrated in colour and half-tone, and by line drawings. The historian of the English in the Peninsula will find not a little to interest him.

"The Alps of the Bernina.' By E. L. Strutt. (London: Fisher Unwin. 1910. Part i., pp. xxiv., 234; part ii., pp. xxiv., 232. 10*s.* each.) These belong to the well-known series of Conway and Coolidge's Climbers' Guides. They are in pocket-book form, of convenient size, and with sheets bound in for the mountaineer's own notes. The careful directions as to ascents and the notes closely correlating authoritative maps are the chief features.

ASIA.

Chinese Life and Character.

'Changing China.' By the Rev. Lord William Gascoyne-Cecil, assisted by Lady Florence Cecil. London: Jas. Nisbet & Co. 1910. *Sketch-map and Illustrations.* 10*s.* 6*d. net.*

This is not a geographical work, but it is one that travellers might do well to peruse and study, for it contains a fund of information regarding the opinions, customs, idiosyncrasies, and modern life of one of the oldest nations of the world. Considering the vast extent of the country, the surprising variations of climate and racial and ethical characteristics, nothing is more misleading than to attempt to generalize about China and its people. The only way to understand them is to accumulate trustworthy data from competent judges, and from these to deduce general conclusions. But to arrive at this stage, the observer must be keen-sighted and unprejudiced, and have traversed a wide area of country. In regard to the last point, the author appears to have visited Peking, Shanghai, Changsha, Nanking, and Hankow, five important but widely distant centres, while in his interviews and discussions with numerous high officials, gentry, and literati, he seems to have invariably treated them with a pleasing consideration and sympathy. Hence we are presented with a far more reasonable and interesting picture of the native mind and even native prejudices than we gather from some other well-known works. Of course, the general trend of the chapters is social and philosophical rather than material. We regret that several of the most striking and characteristic stories are too long and otherwise unsuitable for quotation in a geographical magazine, but it may be remarked of them generally that they certainly tend to prove the enormous—nay, almost insuperable—difficulties that beset all efforts to assimilate East and West.

'Persia in Revolution.' By J. M. Hone and P. L. Dickinson. (Dublin: Maunsel; London: Fisher Unwin. 1910. Pp. xiv., 218. *Map and Illustrations.* 5*s. net.*) The title sets the main theme, but the book develops it, to say truth, rather incoherently, and imaginary conversations between the Shah and the revolutionaries, done into colloquial English, are not particularly illuminating. But if one gathers nothing very definite as to the causes, effects, or proceedings of the revolution, at least the authors saw Persia under peculiar conditions, and these, together with the country travelled, they describe clearly and in a reasonable manner. They covered no little-known ground in the empire, and provide perhaps their most interesting matter in the last two chapters, which deal with Georgia. The map has the peculiar demerit of wrong orientation.

'Cook's Handbook for Tourists to Peking,' etc. (London: Simpkin Marshall, and Thos. Cook. 1910. Pp. 116. *Maps and Illustrations.*) This convenient little guide covers, besides Peking, the chief towns on the Gulf of Pe-chilili, and Mukden. It is clearly printed and the information is well chosen. There is a Chinese (Pekinese) vocabulary.

'In Lotus-Land Japan.' By H. G. Ponting. (London: Macmillan. 1910. Pp. xvi., 395. *Illustrations.* 21*s.*) The disadvantage of a fanciful title like this is that it so often connotes a valueless type of book, whereas Mr. Ponting's is the opposite. For the text he does not claim any distinction, and in truth it is at times rather diffuse, though he describes familiar scenes in Japan much more closely and accurately than many another writer. But from Mr. Ponting as a photographer we know what to expect, and he does not disappoint us. His photography is superb, and the process-engraver has ably seconded him. In

particular, the coloured plates are beyond praise in accuracy and delicacy. The British Antarctic Expedition should be well served by the camera in Mr. Ponting's hands.

AFRICA.

Zambezia.

'Zambezia: a General Description of the Valley of the Zambezi River from its Delta to the River Aroangwa.' By R. C. F. Maugham. *Map and Illustrations.* London: John Murray. 1910. 15*s. net.*

In this book Mr. Maugham does for the valley of the lower Zambezi what he has done in a previous volume ('Portuguese East Africa,' a title too big for its subject matter) for the districts of Manica and Sofala. He gives us, that is, a topographical, zoological, botanical, ethnographical, and historical account of the region. The historical summary is useful and has many picturesque passages; the notes on the natives exhibit a keen appreciation of their good qualities. Taken as a whole, the author regards the native of the Zambezi valley as a fine attractive personality, comparing most favourably, both physically and mentally, with the indigenous tribes of any part of East Africa. Yet he is "incredibly untruthful" and "intensely dishonest." The chapters devoted to the fauna and flora contain much valuable information; never before has this region been treated so thoroughly in this respect. The lists of plants and of the avi-fauna will be welcomed by scientists. Mr. Maugham exhibits, it is true, a very unscientific spirit in describing the insect pests: he "cannot awaken to that condition of mind which professes to see strange beauties and graces in the insect abominations with which poor Africa is so richly, so undeservedly, endowed;" but the author's condition of mind many travellers will comprehend. In discussing the Zambezi, Mr. Maugham states his belief that since the Portuguese first knew the stream (early sixteenth century) its bed below Tete has become much wider and much shallower, and he thinks that ultimately the Zambezi, in its lower course, will cease to exist. "Its course, many times wider than it now appears, will present the appearance of a vast sandy track, over which, after the middle of each rainy season, a shallow trickle of water will pass for a few months seaward, to dry up quickly and disappear with the last of the summer rains." The explanation offered for this hypothesis (see chap. iii.) is not convincing. The further suggestion that Lake Nyasa "may have sprung some terrific leak," and that "an immense foaming torrent . . . may be now delving out the bed of some unknown, unsuspected, and unnamed river" should at least send explorers post haste to the region between the Zambezi and the Rovuma.

Mr. Maugham devotes considerable attention to the economic resources of the country—which are almost limitless—to the system of agriculture in vogue on the prazoes, and to the methods of development adopted by the Zambezia Company. He pays a deserved tribute to the enlightened policy now pursued, in large measure, by the Portuguese in East Africa (a policy comparing favourably with their treatment of Angola). Yet they have strangely neglected the best method of opening up the country, namely, the building of railways. A sketch-map is given, and there are numerous excellent illustrations. Mr. Maugham, it should be added, is British Consul for Portuguese East Africa, and is intimately acquainted with the country he describes.

F. R. C.

German East Africa and the Kamerun.

'Das Deutsche Kolonialreich.' Erster Band. Ostafrika und Kamerun. *Maps and Illustrations.* Leipzig & Vienna: Verlag des Bibliographischen Instituts. 1909.

In projecting this work the publishers intended to make it the standard authority for some years to come on the German over-sea dominions; if a

judgment may be founded on the first volume, they will achieve their object. Twenty-five years have passed since Germany entered the colonial field, a time sufficient to acquire a definite, if still incomplete, knowledge of the vast areas under German rule. The first volume of 'Das Deutsche Kolonialreich' deals with East Africa and the Kamerun. The East African section is by Dr. Hans Meyer, whose competence for the task is unquestionable. Dr. Meyer is also responsible for the general plan followed in the account of each colony or protectorate. He claims that this is the first comprehensive survey of the German colonies on the basis of scientific knowledge. It is written, however, for the general reader, and in non-technical language. Dr. Meyer's own section—East Africa—is considered under three heads: (1) generalities; (2) regional descriptions; (3) economics. In the first division, after an historical sketch, the author points out the importance of the country in world politics (as cutting the Cape to Cairo connection of the British), and then describes its geological structure, topography, climate, flora, fauna, and peoples. All this goes into 84 pages, while the regional descriptions cover some 300 pages. The last section, on the products, trade, and plantations, is brief, but is satisfactory as showing that there is a commercial future of importance for German East Africa. Dr. Meyer writes simply and attractively, qualities which make it easy to assimilate his information (brought up to 1908). The historical section is perhaps too brief. It is certainly dispassionate; we should have been glad to have had more than a reference to the *kolonialen Sturm-und-Drangjahren*, and to have had more than the few lines allotted to the Arab and Portuguese periods. However, 'Das Deutsche Kolonialreich' is not intended to be controversial, nor an historical treatise, neither does it take the place of books of travel. But for the geographical, zoological, botanical, and ethnographical aspects of German East Africa, Dr. Meyer's account will satisfy all save the close student of one particular subject, and it renders obsolete a good many volumes on the country.

The Kamerun section of the book is by Dr. Siegfried Passarge, one of the best equipped of modern explorers in West and South-West Africa. There is both directness and distinction about his writing, and he here deals with a region in some respects more interesting than East Africa. The opening passages of his historical summary vividly recall the race between Germany and Great Britain to secure possession of the Kamerun, but Dr. Passarge refrains from polemics. We fail to notice any reference to Alfred Saker, or to the good work done in the Kamerun by other Baptist missionaries years before the advent of the Germans; the later work and influence of Swiss and German missions seem also overlooked. Save on the economic and political sides, there is a tendency to ignore the results of European intervention. With minor modifications Dr. Passarge follows, in his treatment of the Kamerun, Dr. Meyer's thorough and methodical system. The chapters on the ethnological and philological tangle which the country exhibits are particularly instructive.

After each of the two main divisions of the book is a series of coloured maps drawn by experts, *e.g.* Prof. Schenck (geology), Prof. A. Engler and Dr. Lauterbach (botany), Prof. K. Weule (ethnography). These maps embody new material and are of distinct value; they are clearly printed, and are accompanied by technical dissertations. There are also maps, sections, and diagrams in the text, and an almost lavish number of other illustrations, those of the landscape and the peoples being specially attractive. Six coloured plates of characteristic scenery, drawn by Hans Busse, are included. Dr. Meyer has a classified bibliography extending to 482 entries. Dr. Passarge's bibliography is less complete. It has fifty-four entries, but has not, for example, Sir H. H. Johnston's book on Grenfell. References to authorities are made in the text by means of numbers. The index

contains many names, but is not analytical. The "Bibliographisches Institut" deserves high commendation for the manner in which the volume has been produced.

F. R. C.

SIERRA LEONE.

'A Transformed Colony: Sierra Leone as it was and as it is.' By T. J. Alldridge. *With 66 Illustrations and a Map.* London: Seeley & Co. 1910. 15*s.* net.

Mr. Alldridge for many years held important political posts in Sierra Leone, and in a previous work described the Sherbro and its Hinterland. He has recently revisited the colony and protectorate, and his new book, which deals with the country as a whole, is mainly a comparison between the conditions existing now and some forty years since. The contrast is striking, and bears eloquent witness to the beneficent work accomplished by Government officials and missionaries in that part of the empire. Mr. Alldridge's book is interesting, and it contains much information of considerable value; its chief defect seems to be a certain want of method in the arrangement of the material, and, in the earlier chapters, a tendency to repetition and the giving of unnecessary details. These chapters bring out very clearly, however, the civilizing effect of the building of the railway from Freetown to the Liberian frontier.

The book contains, on the topographical side, besides descriptions of the country through which the railway passes, an account of Mendiland and of the coast from the Liberian frontier to Freetown. Of greater value are the detailed descriptions of various secret societies. In particular, the account of the Bondu order for women may be instanced. In other chapters we see how fetish is employed to regulate the proper gathering in of grain crops and the oil palm industry. A note contributed by Major G. d'Arcy Anderson gives an authoritative account of the curious steatite and soapstone carvings found in the protectorate, the work of an earlier, and probably more civilized, race than any now inhabiting the country. Of the existing tribes Mr. Alldridge speaks of the Mendi as the coming race. He deplores the almost exclusive addiction of the Sierra Leone "creoles" to trade, pointing out that between the competition of the European merchants and of Syrians, recent immigrants, they are steadily losing ground. On two points the author is insistent—the capacity of the country for an immense development of trade in rice and in palm oil and other jungle products, and on the salubrity of a great part of the protectorate. He even recommends Sierra Leone as a health resort in the dry season. Chapter xxvi. is devoted to an account of land and water fauna, chapters xxxiv. and xxxv. are given up to the flora; the oil palm being pre-eminent.

One chapter deals with mission work, and another rather sketchily treats of the causes, chiefly slave raiding and tribal wars, which led to the extension of British authority inland. A valuable section of the book gives the story of a mission undertaken in 1890 by Mr. G. H. Garrett in the north-east part of the hinterland, where the French were pushing forward. This account consists mainly of extracts from Mr. Garrett's log book, and it has all the charm of actuality. Mr. Garrett crossed the Niger and visited the great warrior Samory, with whom he signed a treaty placing the Almani's empire under British protection (a treaty nullified by latter agreements between France and Great Britain). Accounts of Samory and his court by eye-witnesses are rare, and Mr. Garrett's will be read with much interest. The map given is that of the War Office on the 1 : 1,000,000 scale corrected to April, 1909; the illustrations are almost uniformly good.

F. R. C.

West African Coast-lands.

'A Travers la Mauritanie Occidentale (de Saint-Louis à Port-Etienne).' By A. Gruvel and R. Chudeau. Vol. 1, Partie Générale et Économique. 80 *Illustrations and* 2 *Maps.* 281 pp. Paris: 1909.

A somewhat detailed account of the contents of this work was supplied before its publication by the authors to *La Géographie* for July, 1909, and noticed at some length in the *Journal* for October, 1909. Here it will suffice to complete that notice by a brief reference to some of the more important points that have come to light since the summary of the first volume appeared; the second, which is occupied with the scientific part, still awaits publication, but is promised for an early date.

The book itself may be regarded as a crushing reply to those pessimists who denounced the establishment in 1906 of the French station of Port-Etienne near Cape Blanco as a rash speculation, which could never yield any adequate returns for the time and treasure wasted on its foundation. Hence the main object of the mission was to show that there were abundant resources along the surveyed seaboard to warrant the undertaking and enable the new station to become a flourishing commercial centre. After the long historic survey already referred to, the route is described in great detail, and here a vivid account is given of the surrounding "Moorish populations," as the French call with little discrimination all the Arabo-Berber peoples of "Mauritania," that is, the Saharan coastlands between Morocco and Senegambia.

That the whole region formerly enjoyed a much more favourable climate than at present, and was fairly well inhabited throughout the Stone Ages, results from the discovery of numerous flint and other worked objects at various points along the route. From primitive workshops like those of Gaul and Britain were collected numerous specimens of spear or arrow-heads, scrapers, cutters, hatchets, and at pp. 153–4, students of early man will be delighted to find over 120 of such objects clearly photographed. Again we are told that in the Cape Blanco district large numbers of similar implements may be found intermingled with chipped (palæolithic) or polished (neolithic) stone objects often fashioned with much skill and taste. We seem to have here a further proof that the Afro-European peoples ranged from Africa northwards into Europe, as I have always maintained, and not from Europe southwards, as is held by perhaps the majority of our leading anthropologists.

The explorers find that the Mauritanian coastlands traversed by them present, from the economic standpoint, only three natural products capable of being exploited either now or in the near future. These are stock-breeding, salt, and fishing, this last the most important of all. A. H. K.

South Africa.

'History of South Africa since September, 1795.' By G. McCall Theal, LL.D. In 5 volumes. *With Maps and Charts.* London: Swan, Sonnenschein: 1908. 7*s.* 6*d.* each volume.

Complete or partial editions of Dr. Theal's 'South Africa' appear so frequently that it becomes somewhat difficult to grasp the general scheme of this truly monumental work. As, however, it has already been frequently noticed in the *Journal*, it will suffice here briefly to state that the five volumes under notice deal only with the period from 1795 to the present time.* The "Chronological List of Events" stops in vol. 5 at the year 1895, and the reader is left in doubt

* The earlier period is dealt with in a separate work, in three volumes, entitled 'History and Ethnography of Africa South of the Zambezi.'

as to whether this is to be taken as the concluding part of the present issue. He gets no help from the title-page, which only gives the starting point (1795), and one asks with some perplexity, why stop at 1895? But, however this may be, all that can here be done is to give in rough the contents of the several volumes, at least so far as they differ from the previous editions. Each is furnished with a very full synoptical index, and can be had separately.

In Vol. 1, which covers the period from 1795 to 1828, there is a new preface dated July, 1908, in which the author justly claims that the work is "not alone the only detailed history of South Africa yet prepared, but is a true and absolutely unbiassed narrative." There is also an added note in which the terms Hottentot, Bushman, and Bantu are dealt with.

Vol. 2 runs from 1828 to 1846 for Cape Colony, from 1824 to 1845 for Natal, and from 1836 to 1847 for the Boer trekkers; no added matter.

Vol. 3, Cape Colony from 1846 to 1860; Natal from 1845 to 1857; Kaffraria from 1847 to 1860; Orange and Transvaal Republics from 1847 to 1854. Added matter: (1) List of recently published works on South Africa; (2) Knowledge of bronze possessed by the Bantu; (3) Absence of phallic worship amongst the Bantu.

Vol. 4, Orange and Transvaal States; Zulu, Basuto, Bechuana and Matabele lands from 1854 to 1872. Added matter: (1) Search for the first Bantu tribes; (2) Rapid increase of the Bantu in South Africa between 1839 and 1889.

Vol. 5, Cape Colony and Natal to 1872; Griqualand West to 1880; Great Namaqualand, Damaraland, Transkei, Tembuland, and Griqualand East to 1885; Pondoland and the Portuguese Territory to 1894. Added matter: (1) List of books and pamphlets about South Africa in recent times; (2) Chronological list of principal events in South African history; (3) Notes on the Bushmen and their language.

A. H. K.

AMERICA.

North-Western Brazil.

'Zwei Jahre unter den Indianern: Reisen in Nordwest Brasilien 1903-1905.' Von Dr. Theodor Koch-Grünberg. 2 vols., separately paged and with partly separate titles. 1. Pp. iv., 355; 227 *Illustrations in text*, 12 *Plates, and Map.* 2. Pp. 413; 218 *Illustrations*, 10 *Plates, and* 4 *Maps.* Berlin: Ernst Wasmuth. 1910.

Amongst recent explorers in South America, where, strange to say, the largest area of unsurveyed land is still to be found, no name stands higher than that of the author of this thoroughly comprehensive account of the north-west region of Brazil, its land and peoples. Dr. Koch-Grünberg had already distinguished himself as one of the most intelligent and discriminating observers of the native races during the memorable expeditions led by Von den Steinen and Ehrenreich to the Xingu and other southern tributaries of the Amazon towards the close of the last century. Now he has transferred the scene of his operations to the other side of the great river, where he has gathered a rich harvest in the Rio Negro basin, and more particularly in its hitherto much neglected Uaupes tributary and its numerous affluents right up to the Colombia frontier. A clear idea of the vast area covered during the two years 1903–5 is given by the map showing his routes along the main streams from Manaos to their sources, and down the Yapura back to Manaos at its junction with the Amazons.

It is impossible in a few lines to convey an adequate notion of the immense amount of work done; but it may be stated that hundreds of points were astronomically fixed, over 1000 photographs were taken and developed on the spot, thus giving endless views of the physical features, scenery, and general aspect of

the land; representing also incidents of travel and numerous types of tribes, single and in groups, with their industrial and social pursuits, games, dances, and many other details. There are, further, many vocabularies and other specimens of over forty languages, some quite new, and the materials were thus supplied for the 467 illustrations with which the two volumes are enriched. To these and other particulars several references have already been made in the *Journal* for the years 1905–6.

Of the multitudinous details many are of quite exceptional interest. Thus we are told that several of the nominal "Christians" celebrate pagan rites, because they have many chapels, but not a single priest to conduct the service properly. Hence they keep the feasts with the strangest "religious ceremonies accompanied by copious draughts of rum."

The strange species of cannibalism referred to by Wallace on hearsay is here confirmed, and we read how fifteen years after burial the bones of the dead, all but the skull, are dug up and burnt in a great fire before the house. Then the carbonized remains are swept together, put into a pot, and set on the fire, which is kept up day and night for a whole month until the contents are reduced to ashes. These are put into a large kettle full of beer, and at the feast of the dead passed round to the invited guests after being poured through a fine sieve. The origin of this singular custom, which appears to be widespread, may be sought in the belief that the bones, which alone survive after the decay of the body, are the last abode of the soul.

In some districts the world-wide werewolf superstition assumes a somewhat peculiar form. When a wizard grows old and can no longer move about quickly, he becomes a jaguar; that is to say, he goes from time to time into the woods, where he changes to a jaguar, when he kills and eats deer, aguti, and other animals as well as men. On his return from the forest he again becomes a man and hides his jaguar-skin in the rafters over his bed, and when he dies this skin is buried with him. His soul, however, does not pass into the next world, but prowls about for ever in the neighbouring woodlands as a "very wicked jaguar." Here we have the clue to the fact that in several of the local languages the same word means both jaguar and magician.

A. H. Keane.

Note.—This review was written before the appearance of Dr. Hamilton Rice's article on the river Uaupes in the June issue of the *Journal*. This is a valuable paper as far as it goes, but Dr. Rice spent only nine months in the country, while Dr. Koch-Grünberg covered the same ground several times over.

'American Inland Waterways.' By Herbert Quick. (New York and London: Putnam's Sons. 1909. Pp. xx., 241. *Illustrations.* $3.50.) This is a close study not only of American and Canadian waterways themselves, but also of their economic position. In spite of the vast volume of traffic on some canals in the states it would seem that in many cases their trade and utility are approaching the stifled condition of those in the United Kingdom, and for similar reasons. The questions raised are controversial, and the author holds strong opinions. His view of the advantages of Canadian waterways, existing and potential, over American, with especial reference to the grain transport trade, are of particular interest to us in this country. The illustrations are numerous and good, and largely of a technical character.

'The Picturesque St. Lawrence.' By Clifton Johnson. (New York: The Macmillan Co. 1910. Pp. xiii., 253. *Illustrations.* 5*s.*) The St. Lawrence

is surpassed in historical and general interest by few rivers in the old world and by none in the new. It is principally to the historical interest that the author gives attention. The volumes of this "Picturesque River" series, in fact, are in character not unlike those of the English "Highways and Byways" series, while there is also enough travelling information to make them helpful as well as interesting to tourists. There are some good photographs, but the St. Lawrence is really too big for the camera.

'Ponce de Leon: The Rise of the Argentine Republic.' By An Estanciero. (London: Lawrie. 1910. Pp. x., 435.) A publisher's note states that this book was originally published in 1878, has been long out of print, but "has been recognized as the best and most accurate description yet written of the British invasion, and the rise of the Argentine Republic." It is further unusual as being cast in fiction-form, being full of conversation and nowhere written in the impersonal manner of history. The result is an exceedingly vivid story, with enough historical fact interwoven to make the whole much more instructive than the best type of historical novel. One result, of course, is a certain artificiality, but that is a trifling flaw.

AUSTRALASIA AND PACIFIC ISLANDS.

History of New Zealand.

'Murihuku.' By Robert McNab. Wellington: Whitcombe & Tombs. 1909. Pp. xv., 499. *Charts and Illustrations.*

In any future work on New Zealand where an historical conspectus of the South island is called for, there will be no excuse for passing lightly over the earliest period, for Mr. McNab would seem to have made researches in this subject so thorough that they are done once for all. Though he deals suitably with Tasman's discovery and the visits of Cook and Vancouver, these parts of the story are less fully treated, as being accessible elsewhere, than the part which Mr. McNab has made his own—namely, the work of the sealers and other adventurers from the earliest years of the nineteenth century. His researches have led him far afield. Australian newspapers of the period, newspapers and log books preserved in libraries in the eastern ports of the United States, whence so many vessels visited the South Seas at the period under notice, and documents and books in our own Record Office and the British Museum, were not the only sources laid under contribution. The author deals fully with the little-known voyage of Malaspina in 1793, and that of Bellingshausen in 1820, so far as they were concerned with his area, which, it may be added, includes the Macquarie and other antipodean island-groups. Much of the detail of the early adventurers' work is trivial in as far as that work left little impression on the future colony; its justification is its extraordinary interest and its typification of the Australasian outlook and atmosphere of the time. Page after page, often reproduced verbatim from contemporary journals and written reports, reads like the best type of boys' story-book; we hear of battles with storms and hostile natives, of sealing parties left on desert islands and never brought off by their vessels, of ships which sailed to unknown disaster, of wrecks discovered but never recognized. The author himself gives the palm of his research to the discovery of the log of an officer who served on three vessels, including the *Endeavour*, the wreck in Dusky sound about which so much romance has been woven.

Such is the story; as history there is little fault to find with the work. It is less the writer's fault than that of his material that the narrative seems occasionally dislocated and a little difficult to follow. A few of the actors on the stage (*e.g.*

certain of Cook's scientific companions) are unidentified beyond their surnames, when identification should have been possible. The *errata* noted are not the full sum of misprints. There are some excellent reproductions of original charts, ever before published, and there is a full analytical index.

O. J. R. H.

POLAR REGIONS.

A Trip to Novaya Zemlya.

'Dans l'Océan Glacial et en Nouvelle-Zemble.' Par le Commandant Charles Bénard. Paris: A. Michel. [1909.] 10 *fr.*

This expedition (April—September, 1908) was organized under the auspices of the "Société d'Océanographie du Golfe de Gascogne." The expeditionary ship, *Jacques-Cartier*, being a sailing vessel of the same class as those used by the French mariners in the Iceland fisheries, was unsuitable for scientific investigations in the Barents sea, and along the shores of Novaya Zemlya, where to successfully pursue such an enterprise steam-power is indispensable. Under the circumstances Commandant Bénard and his scientific companions carried out a very considerable amount of research work, both by sea and land. The *Jacques-Cartier* did little more, as far as cruising around Novaya Zemlya, than find an anchorage in the Kostin Shar, and act as a depôt ship. Some interesting perambulations were made, especially in Goose Land. The chief feature of the land exploration was a journey made by Dr. Candiotti, the medical officer of the expedition, who, accompanied by Samoyedes from their settlement at the western entrance of the Matyushin Shar, traversed that strait in open boats, entered the Kara sea, and landed on the east coast of the North island, or Lutke Land. From thence Dr. Candiotti crossed to the western, or Barents sea, side. This excellent journey was carried out by Dr. Candiotti under very trying circumstances, which in a great measure might have been avoided or greatly minimized had the expeditionary ship possessed steam-power to enable it to pass through the Matyushin Shar and land the party on the eastern shore of Lutke Land. Valuable collections appear to have been made in the several departments of natural science. The book is well got up, and beautifully illustrated.

'The Siege and Conquest of the North Pole.' By George Bryce. (London: Gibbings. 1910. Pp. xv., 334. *Maps.*) After a very brief introduction regarding earlier work, this volume carries the story of the North Pole from Parry in 1817 nearly to the present day, but not quite, for this is another work which has apparently been hurried to press before the recent controversy was settled. Close writing and judicious, not excessive, quotation make this a useful handbook of reference which would have been improved by an index. "It is hoped," in the preface, "that the maps may be of considerable assistance in enabling the reader to follow the narrative." This is hardly the case, as they are largely illegible through over-reduction.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

A Treatise on Physical Geography.

'Traité de Géographie Physique.' Emmanuel de Martonne. Paris: Armand Colin. 1909. 22 *fr.*

Every writer and lecturer on Physical Geography has to face the difficulty of finding a starting-point and maintaining a logical sequence of treatment, for each main division of the subject is necessarily so intimately correlated with all the

rest that to treat it without presupposing a considerable knowledge of the others is impossible. Prof. de Martonne has achieved a conspicuous success in this respect, his compromises being reasonable and such as would not make any difficulty for a student who is serious enough to work with a comprehensive treatise of this type.

The book gives a very broad survey of natural phenomena and their causes, and in most of the sections there are luminous suggestions concerning the bearing of physical facts on human interests and activities, suggestions which greatly increase the value of the book to the modern teacher, who must endeavour to appreciate the physical basis of economic and general human developments. It is a great feature of the book that the chief sections begin with succinct accounts of the instruments and methods of scientific observation of the facts of the subject in hand. The accompanying diagrams of methods and illustrations of apparatus are good and well chosen.

The Earth is first treated from a cosmic standpoint, and this leads on to a discussion of the methods used in representing its surface on maps. While maps of large areas continue to be so largely used for teaching purposes in place of globes, the study of map projection must be a very important one, especially for the teacher, and the treatment of this difficult subject is unusually clear.

The chapters on climate feel most of all the difficulty already mentioned of the interdependence of the factors concerned, but the reader is much helped by a discussion of the various types of weather and climate at the end of the section. It is unavoidable that this should be incomplete here and there, for while climate is certainly definable as the assemblage of meteorological phenomena which characterize the average condition of the atmosphere at one point of the Earth's surface, those phenomena largely depend upon facts of oceanic circulation and the distribution of land-relief, which are treated in later parts of the book.

In discussing climate it may be noted that the author uses the term "Gulf Stream" for the drift which tempers the climate of western Europe, but he discusses the matter in his account of ocean currents later on. The numerous climatic maps of the world and of special regions are most valuable and often suggest lines of thought with regard to human affairs which are beyond the scope of the book.

As an example of the importance attached to scientific observation, we may note that the hydrographical section includes a consideration of sounding apparatus, of the first-hand facts about deep-sea deposits, of ocean temperatures at the surface and at different depths, and a special consideration of the distribution of salinity, including those of several of the smaller expanses of sea-water. The section on lakes is rather less satisfactory, perhaps, because it is difficult to treat it without emphasizing special cases in a way that would bring it detailed discussion of orogenic movements.

The first chapter on topography gives a useful account of methods of surveying, and then develops the subject in the usual fashion, but with good European illustrations wherever possible—a valuable feature when one remembers to what an extent the American examples of physical features chosen by the geographers of the United States have been the resource of most students and writers dealing with physical geography. The influence of rock types and of earth-movements seems to be admirably treated, and there is a short section applying the facts previously studied to the study of the general evolution of relief and of the broadest conclusions in Palæogeography.

The chapter on glaciers and ice-action is supplemented by an unusually fine series of photographic illustrations, and the serious discussion of the features of deserts with the numerous illustrations is of great assistance, especially to those who have not had an opportunity of seeing the great deserts for themselves.

Brittany and Normandy naturally provide many examples made use of in the discussion of coasts.

The author departs somewhat from precedent in devoting a large section to biogeography, and commences the discussion of animal and plant distribution with a brief sketch of some general biological laws and of the relation of living things to their environment. The section on plants is particularly valuable, as œcology is often neglected by purely botanical writers, though it adds such living interest to the study of anatomy and systematics and forces itself on the geographer's attention by giving innumerable hints about the influence of plant-life on mankind. The zoological section is not so detailed, but it suffices to interest the general reader in the question of the distribution of animals, and even touches the complex subject of special adaptations; the technicalities of structure of unfamiliar animals would indeed preclude a more thorough study of the subject in a work on geography.

The bibliographies at the ends of chapters throughout the book are a satisfactory feature, even though no two students could entirely agree in the selection of a list of works of reference.

Prof. de Martonne has certainly produced one of the best treatises on his subject, and one which affords an interesting and well-directed general introduction to that detailed study of the geomorphology of special districts which forms such an important part, for example, of the standard work by the late Prof. de Lapparent. H. J. F.

GENERAL.

Educational.

'The Teaching of Geography.' By L. W. Lyde. London and Edinburgh. Blackie & Son. 1909. 1*s. net.*

Mr. Lyde makes many useful suggestions. Physical geography should, he says, not be taught apart from political and economic. Unfortunately, he gives no instances of the too common practice of teaching the subject in separate compartments. The examination of a rain-gauge, for example, is of little use except as a means of giving reality to the consideration of rainfall as a problem in climate. We agree with Mr. Lyde that the political unit should be made the basis of regional work, the relations of the different natural regions of any political unit to the world as a whole being studied in addition. The book would be of much greater value if it gave more practical hints as to the methods which a teacher should adopt. We gather that Mr. Lyde deprecates hints to teachers, but their need is obvious in the modern chaos of geography teaching. A. W. A.

'Man in Many Lands.' By Prof. L. W. Lyde. London: Black. 1910. Pp. viii., 184. *Illustrations.* 2*s.* 6*d.*

This book may attract students to the study of geography. It is eminently readable, not very deeply reasoned, not arranged on a strict system, but full of varied information, some of which ought to remain in the mind after reading. The purpose of the book is to serve as an "introduction to the study of geographic control," though perhaps some of the facts are strung on to this purpose by rather slender threads. The style is somewhat colloquial. The arrangement is so far systematic as to take examples of certain controlling geographical factors—such as monsoon conditions, regions of extreme temperature, forest land, and the like—and append the characteristic conditions of human life to them. The plan of illustration in colour is no doubt attractive to the student and may be instructive, but both

water-colour artists and the three-colour process take liberties sometimes—we have grave doubts as to the colouring of Scafell, and none at all as to the inaccuracy of the Swedish scene illustrating the timber industry.

O. J. R. H.

'An Elementary Practical Geography.' By Frederick Mort. (London: Blackie. 1909. Pp. 91. *Diagrams and Illustrations.*) A concise work on map-drawing, surveying, position-fixing, and the use and compilation of maps illustrating distribution, etc. The text is brief, but gives a number of exercises, and will therefore serve both student and teacher, especially as there is a useful chapter on the simpler forms of surveying instruments, with illustrations and references to the makers. The illustrations throughout are particularly clear and appropriate.

'Le Réseau Anglais de Cables Sous-marins.' By Dr. M. de Margerie. (Paris: A. Pedone. [*N.d.*] Pp. 202. *Plans.*) This is a valuable technical work on the history, and the financial and other working conditions, of the chief cable companies, their arrangements with government, and so forth.

'The Senior Scientific Geography.' By Ellis W. Heaton. (London: Ralph and Holland. 1910. Pp. 861. *Maps and Diagrams.* 5*s.*) The seven books of Mr. Heaton's "Scientific Geography" are here collected into one, with certain omissions on the one hand and additions (*e.g.* a section on South America) on the other. In the result we find a volume carefully and systematically arranged, with an error, it may be suggested, in the direction of multiplicity of details: perhaps the volume, on the whole, would be more greatly appreciated by teachers than by students. The diagrams are clear and well chosen. In the process of editing the original volumes for the purpose of this composite volume some further revision might have been applied in parts. To take two examples—the population of Winnipeg has grown very far beyond fifty thousand, and the Canadian Northern railway has extended far beyond Battleford.

THE MONTHLY RECORD.

EUROPE.

The Howgill Fells.—An interesting account of this block of hills on the borders of Westmoreland and Yorkshire, from the point of view of the evolution of its present topographic forms, was contributed by Dr. J. E. Marr and Mr. W. G. Fearnsides to the *Quarterly Journal of the Geological Society* at the end of last year (vol. 65, part iv.). The tract, which lies immediately east of the Lune valley, near Tebay, forms a well-defined geographical unit of roughly triangular form, being separated by a continuous depression from the adjoining heights on the west, north, and south-east. Geologically, also, it has a distinct individuality, consisting essentially of Silurian rocks, the line of partition between which and the Carboniferous runs along its north and south-east sides. The Fells constitute a monoclinal block, with its dip slope to the north and its scarp facing south, and could the hollows produced by erosion be filled in, we should have a "desk"-structure, with the long gentle slope to the north and the short sharp drop to the south, the east-to-west summit-ridge running, at a height of about 2000 feet, quite close to the southern edge. The original base of the Carboniferous strata probably coincided closely with the general plane of the present surface; but south of the Howgill fells the lowest Carboniferous rocks

have been let down by a great complex fault—that by which the steep southern face of the block has been determined. The persistence of the tract as an upland area surrounded by lower ground was due to the relative hardness of the Silurian rocks. On the dip-slope of these a series of northward-flowing streams was developed, and to these the early dissection of the block-tract was due, while subsequent modifications of drainage were due to the tendency of the short, swift southward-flowing streams to cut back into the watershed, and thus capture the headstreams of those which originally followed the dip-slope. An interesting feature is the presence within a limited area, formed of practically homogeneous rock, of ice-worn valleys, and of others showing no sign of glacial erosion, affording an instructive contrast between the effects of stream and ice erosion.* The authors describe in detail the characteristics of the several valleys, showing the effects of the ice-action, and explaining the processes by which diversions of streams have taken place. Interesting instances are given of diversion by delta-growth, especially in the case of the headstreams of the Carling Gill and Uldale becks, where such diversion is seen in actual process at the present time. The upper part of Cautley beck also supplies a striking example of a series of captures, which, beginning in pre-glacial times, have continued through glacial time to the present day. In summing up their conclusions, the authors point out that the erosive effects of the ice have been chiefly in the direction of widening the valleys and truncating the spurs, the amount of deepening being small, and the hanging of the tributaries therefore insignificant.

The Underground System of the Timavo, near Trieste.—Experiments recently carried out with chemicals have thrown new light on the underground system of the Timavo, the stream, famous in antiquity, which debouches into the Gulf of Trieste after making its exit as a full-grown river only a couple of miles from its mouth. According to a note communicated to *Globus* (vol. **98**, No. 1) by Dr. L. K. Moser, the main point to be settled was the supposed connection of the Timavo with the Wippach (which flows from east to west into the Isonzo some 8 miles to the north of the Timavo exit), by way of the lakes of Doberdo and Pietra Rossa. The idea that such a connection existed has been fully confirmed by the experiments. The proof was obtained by casting 10 kilogrammes of lithium chloride into the Wippach at Vertoche, near Biglia, and carrying out the necessary examination of the water in the lakes and the Timavo. Other experiments finally confirmed the identity of the Reka (which takes an underground course at St. Kanzian) with the Timavo, and also showed that the underground section of the river gives a portion of its water to feed the springs of San Giovanni near Trieste, of Cedassamone, and Auresina. The network of channels forming, as it were, the underground delta of the Timavo has also been elucidated, and their relation with the rifts and caverns of this district established.

ASIA.

The Ice Age in India.—In the *Geological Magazine* for May, 1910, Mr. T. H. D. La Touche discusses the question whether relics of the Ice Age may not be recognized in the plains of Northern India in the form of the elevated patches of "older alluvium" (generally of a red colour, and containing the nodular limestone known as "kunkur"), which occur in many parts of the Ganges valley and neighbouring districts. He points out that the high-level terraces in the Himalayan valleys, which have sometimes puzzled geologists, seem to owe their origin to the

* During the glacial epoch the fells seem to have formed an independent centre of glaciation, the ice flowing from the present watershed down the three sides of the triangle.

exceptional accumulation of *débris* during the Glacial period, owing to the destruction of vegetation and consequent increased erosion at that epoch; and asks if it is not "reasonable to suppose that it was then that the lower valleys of the same rivers were choked with a superabundance of silt, and that to this same period we must attribute the formation of the 'older alluvium.'" One of the most conspicuous instances of the occurrence of this deposit is in the elevated tract known as the Madhapur jungle, lying between the present channel of the Brahmaputra and its old course to the Megna. Fifty years ago Mr. J. Fergusson, in his discussion of past changes in the courses of the Ganges and Brahmaputra (*Quart. Journ. Geol. Soc.*, vol. 19), suggested that this elevated tract originated in a special upheaval of that part of the delta of the two rivers, but Mr. La Touche suggests that the difficulties may be better cleared up by adopting the above theory of the accumulation of the alluvium during the glacial epoch. In the last part of the paper he attempts a reconstruction of the history of the Brahmaputra and its wanderings, but it must be confessed that speculation plays too large a part in the attempt to allow the conclusions to be very convincing. A good deal of importance is attached to the possible capture of the Sanpo by the Brahmaputra in geologically recent times, which, it is thought, brought in an "enormous accession of water;" and enabled the Brahmaputra to assert its supremacy over the Ganges. This seems to be assigned to so recent a date that its final result was only consummated a hundred years ago, when (owing, in part, to the desertion of the Ganges by the Tista in 1787) the Brahmaputra formed its new channel by way of the Jennai. The "enormous accession" above referred to seems hardly consistent with the idea that the Sanpo may have previously "lost itself in the deserts of Tibet."

The Newly Discovered Peaks in the Karakoram.—In response to a communication from the Council, the Government of India states in a letter to the secretary that it "concurs in the view that it is important to determine the height of the peak observed by Dr. Longstaff during his expedition to the Karakoram mountains, and hopes that the officers now working on the triangulation of Kashmir will be able to take the necessary observations in the next two or three years."

Positions fixed by Major D'Ollone in North-Western China.—The result of observations during Major D'Ollone's expedition in the region of the upper Hwang-ho has been to place the great elbow of that river nearly a degree east of the position previously assigned to it, thus necessitating a revision of the map of the whole region. At Lieut. Filchner's request, Major D'Ollone has had Captain de Fleurelle's observations at this part of the route worked out at the Bureau des Longitudes, with the following results (*La Géographie*, June, 1910):—

Places.	Latitude.	Longitude.
Sung-pang-ting (centre)	32° 37·5′ N.	101° 8′ E.
Confluence of the Hwang-ho (Matchi) and the Eulta Hwang-ho (Maichu) ...	34° 4′ N.	99° 30·5′ E.
Tangkul, easternmost point on the elbow of the Hwang-ho	33° 34′ N.	99° 50′ E.

We regret to learn that one of the members of Major D'Ollone's expedition, M. Charles Nouette, has died in Paris of congestion of the lungs, at the age of forty-one. He appears to have had special charge of the photographic work of the expedition.

AFRICA.

Captain Haywood's Journey across the Sahara.—A young British officer, Captain A. H. W. Haywood, R.A., has lately made a journey from the Atlantic to the Mediterranean, which, though it has not broken new ground, is of interest as the first carried out by an English traveller in the West Central Sahara for a long period, and actually the first English journey across the desert by the route followed, viz. that from Gao on the Niger to Insalah. That the journey was possible with the means at his disposal is due, no doubt, to the progress made by the French in the establishment of orderly government in the region until lately terrorized by turbulent Tuareg tribes. But even with these advantages the accomplishment of the long waterless stage across the desert known as the Tanesruft involves a considerable amount of hardship. Captain Haywood, who left Sierra Leone early in January, proceeded by the upper Niger to Timbuktu, enjoying some shooting *en route*. His first idea had been to go north from Timbuktu, but from this he was dissuaded by the French authorities, and therefore continued down the Niger to Gao before making up his party, which consisted of only one personal attendant and an escort of six Senegalese Tirailleurs. The latter, however, only accompanied him the first part of the way—as far as Kidal, in Adrar. Here he hired five new camels and an Arab guide, and set out across the 800 miles of desert intervening between Adrar and Insalah. The Tanesruft was crossed by forced marches, only four or five hours' rest being taken in the twenty-four. It was necessary to carry a water-supply for seven days and nights, and this became almost undrinkable, while much discomfort was caused by the furious winds and driving sand. Only three Tuareg were encountered. The worst part of the way had been passed by June 1, Insalah being reached on June 12, and the remainder of the journey performed by way of Wargla, Tuggurt, and Biskra. Captain Haywood speaks highly of the courtesy shown to him throughout by the French officials.

The Rainfall of Rhodesia.—The Rev. E. Goetz, S.J., director of the Bulawayo Observatory, has published in the *Proceedings of the Rhodesia Scientific Association*, vol. 8, part 3, a more elaborate account of Rhodesian rainfall than has probably yet appeared. Most of the rainfall stations are situated in Southern Rhodesia, *i.e.* between the Zambezi and Limpopo rivers. Southern Rhodesia, being in the neighbourhood of the southern tropic, naturally has its rainy season during the summer half of the year—October to March, when the sun is more or less vertical. The dates of commencement and ending of the rains, however, are very variable and uncertain, but in general it is risky to reckon on useful rains after the first week of April or before the last week in October. The dry winter season increases in duration and severity westwards from the Indian Ocean, and is liable to be broken by light cold drizzles or, exceptionally, by heavy storms. In the eastern part of the country, where mountain ranges intercept the rain-bearing winds from the Indian ocean, the rainfall is about 60 inches a year, but the amount greatly decreases in the western interior, being only 25 inches at Bulawayo. Like many hot countries, Rhodesia is subject to terrific "cloudbursts." In January, 1906, 18·58 inches fell in twelve hours, and 1·4 inches in a quarter of an hour. Such rains are of little use economically, as the run off is very great, amounting to over 90 per cent. Thunderstorms are very frequent. It is indeed rare that rain falls in the wet season without electrical disturbance; but this often takes the form of silent lightning, which is not noticeable as a rule during the daylight hours. The severest hailstorm on record occurred in the month of September. The hailstones, which were of very great size, killed many sheep and deer and were still to be found in sheltered nooks on

the third day after the storm, despite the fact that the average day temperature for September is over 80° Fahr. Local thunderstorms apart, the pressure conditions most favourable to Rhodesian rainfall seem to be a steep gradient landwards from the Indian ocean, but so far as the still inadequate meteorological service of South Africa permits one to judge, the passage of rainy depressions across Rhodesia is rare.

Iron and Steel in the Transvaal.—An official report by F. W. Harbord, of the Mines Department, Transvaal, states that titaniferous iron ores (46 per cent. iron with very little silica) exist in outcrop samples near Onderstepoort, but the deposit does not appear continuous over any considerable area. Titaniferous ores occur also in enormous quantities at Magnet Heights. There are large deposits of magnetic quartzites (46 per cent. iron and 24 per cent. silica) in outcrop samples near Pretoria and at Airlie. Capable of producing a good pig iron, these ores would be expensive to smelt. Limestone deposits suitable for blast-furnace purposes are very limited. Promising as have been the small coking experiments, it has not yet been determined whether a hard metallurgical coke suitable for blast furnace practice is obtainable from local coals. On the assumption of a satisfactory coke being obtained, pig iron suitable for foundry purposes and the manufacture of steel by the Basic process can be made from Pretoria and Airlie ores mixed with about 20 per cent. of rich non-siliceous iron ores such as exist in comparatively small quantities in several parts of the country. In conclusion, Mr. Harbord does not consider that an iron and steel plant to manufacture rails, sleepers, bars, wire, galvanized sheets, etc., could be commercially successful. Yet, in view of the possibility of future developments, he urges the immediate prosecution of systematic prospecting of the most accessible ore deposits with a view to the determination of their quality and quantity, and the settlement of the question as to the possibility of the production of a metallurgical coke by coking experiments in modern coking ovens.

Forests of the Gold Coast.—A report on these forests, by Mr. H. N. Thompson, Conservator of Forests, Southern Nigeria, has lately been issued (Colonial Reports, Miscellaneous, Cd. 4993. 1910). Beyond purely technical matters, it contains much that is interesting to the geographer, largely because it has added to the usual cut-and-dry analytical precision of the ordinary report a few broader scientific ideas which vitalize it. In this case the writer, largely inspired by the phytogeographical generalizations of Schimper, has utilized them to great advantage in classifying the forests of the Gold Coast and Ashanti. The third part, which contains the description of the physical features, the classification of plant formations and their characteristics in West Africa, as well as their distribution, is likely to repay careful perusal. Physically, the long strip of land, running at right angles to the coast-line, may be divided into well-defined belts: an undulating coastal plain, with a fairly bold coast-line, a hilly and well-wooded upland leading to the central plateau of North Ashanti, punctuated here by rocky hills, and reaching, beyond the Black Volta, the higher tableland (2000 feet) of the northern territories. Climatic belts of increasing dryness combine with the foregoing to create a fairly regular succession of vegetation zones stretching roughly from west to east. There are the tropical evergreen rain forest, in a belt barely 40 miles broad; the moist deciduous tropical forest, or monsoon forest; the savanna, first heavily stocked with trees, then gradually passing to bush, and then to treeless grassland. The heavy forest belt reaches the coast only in the extreme south-west of the colony. East of Axim there intervenes a drier belt between the evergreen "selva" and the coast-line. This is marked by a strip of savanna, which becomes more and more open as one approaches the coast. Beside

the average rainfall, great importance is ascribed by the writer to relative humidity of the atmosphere, as determining the distribution of the various aspects of the savannas and the tropical deciduous forests. Similarly, the stunting influence on the vegetation exerted by the laterite, with its underlying hard pan, is mentioned. But laterite areas appear to occur but seldom. The danger to the forest resources of the colony lies in the dry and cold Harmattan, which, beyond its harmful influence, spreads the grass fires, and helps the treeless savanna to encroach on the woodlands. The writer estimates that to preserve a sufficient timber-supply for the double purpose of local consumption and export it will be necessary to put under reservation about 40 per cent. of the present area of forests, and he advocates the Government reservation of a protective belt of forests between the planting centres and the dry grass country.

Surveys in Italian Somaliland.—A new departure of some importance has lately been taken by the authorities of Italian Somaliland, in the inauguration of topographical surveys of a higher degree of precision than any hitherto attempted in the colony, where practically nothing in the way of accurate mapping has so far been done. We learn from the *Rivista Geografica Italiana* (June—July, 1910) that, as a result of consultation with the directors of the Italian Military-Geographical and Hydrographical Institutes, it has been decided to make a beginning in the district between the Webi Shebeli and Brava, and in that of Gosha on the lower Jub, these being the parts of the colony offering the best prospects of agricultural development. Bases will be measured and a triangulation carried out, use being made of the points determined astronomically by the Naval Department. The detail will be filled in by the plane-table, and the results plotted on the scale of 1 : 100,000, Lambert's cylindrical projection being used. The survey party, which left Naples early in June, is under the direction of Captain Egidi, who, like his subordinates, has had previous experience in Eritrea. Another expedition, under the command of Captain Citerni, has been organized for the demarcation of the frontier between Italian Somaliland and Abyssinia, as laid down by the treaty of 1908 (*Journal*, vol. **31**, p. 676). The technical part of the work has been entrusted to two experts from the Geographical Institute, and as the ground to be covered is in great part unexplored, important results may be expected.

The Population of Madagascar.—The *Revue de Madagascar* for July 10, 1910, quotes the official statistics of the population of the island at the beginning of 1908. The grand total was then 2,706,661, of which 7606 were of French origin (including those born in Réunion, Madagascar, and other colonies—more than half of the total); 2088 were of European, other than French, origin, including 1255 English; 3602 Asiatics; 1978 Africans; and the remainder, 2,691,387, Malagasy. The two most populous provinces, with totals of over 300,000 inhabitants, were Central Imerina and Farafanga, while Fianarantsoa fell only a little behind that limit. Seven other provinces, out of the whole 30, had a population exceeding 100,000.

AMERICA.

Early English Survivals on Hatteras Island.—In the *University of Carolina Magazine* for February last, Mr. Collier Cobb gives some interesting examples of survivals of old-time speech and manners in a corner of the United States which has, to within the last few years, remained surprisingly untouched by modern influences, viz. the sand reefs of the north Carolina coast, particularly Hatteras island. Before the advent of motor boats, just a decade ago, this formed a sort of World's end, three days' journey from anywhere, and its mild-mannered people were living under much the same conditions as three centuries ago. Hatteras

island is an elbow-shaped sand-spit, 40 miles in length measured round the elbow, and from half a mile to 5 miles in width. It lies along the very border of the continental shelf, 100 miles beyond the normal trend of the coast, between 35° and 30° N. lat. The everyday speech of the people contains words and expressions familiar in old English usage, but, so far as the writer is aware, hardly to be met with in any other part of the United States at the present day. Such are: the verb *to travel* (in the sense of to walk as opposed to any other kind of locomotion); *acre* (in the sense of furlong); *country* (meaning the opposite mainland, as opposed to the islands); and many others. The first named is to be found so used in Hakluyt's 'Voyages,' and is still to be met with in exactly the same sense in various corners of the British Isles. Old English melodies are also still to be met with in Hatteras island, though the songs of the mothers and grandmothers are well-nigh forgotten by the daughters. The writer holds that the grandmothers are well-nigh forgotten by the daughters. The writer holds that the lost colony of Roanoke may have found refuge here, while the above survivals might also be accounted for by wrecks known to have taken place in this locality in 1558 and in 1590. It may be regretted that the levelling influences of "civilization" are already making even Hatteras like the rest of the world.

POLAR REGIONS.

The Mikkelsen Expedition to East Greenland.—Towards the end of August news of this expedition, which went out last year in search of the papers and journals of the ill-fated Mylius Erichsen, reached Copenhagen. The expedition has been unfortunate in losing its ship, the *Alabama*, which is said to have been crushed by ice on the East Greenland coast, apparently near Shannon island (a little north of 75° N.), where winter quarters had been established. It is understood that during the autumn a sledge-party of three had reached Lambert land, and succeeded in finding the body of Bronlund, one of Erichsen's two companions, which was buried on March 3, 1910. On the same day Mr. Mikkelsen, accompanied by Iversen, had started from Shannon island for Denmark fiord, where he hoped to find the papers left behind by Erichsen. He wished, if possible, to reach Cape York, on the western side of Greenland, by way of Peary channel and the inland ice, but should he fail in this he would return to Shannon island, where a house had been built and a depôt of provisions sufficient for two years had been left. As he had not returned by August 7, the rest of the expedition had, according to his instructions, started homewards, reaching Aalesund about the 19th—by what means had not transpired at the moment of going to press.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

The Michael Sars Expedition.—The expedition under Dr. Hjört, financed and accompanied by Sir John Murray, which, as already mentioned, left Plymouth on April 7, has completed its work after a very successful cruise. The observations began off the west coasts of Ireland, and were continued southwards off the west coasts of Europe and Africa as far as Cape Bojador. Thence the expedition went by way of the Canaries and the Sargasso sea to the Azores, and thence to Newfoundland, whence the Atlantic was once more crossed on the homeward voyage. Throughout the cruise both physical and biological observations were constantly made, the number of stations amounting to 74. More than six hundred temperature observations were made at various depths (samples being collected at the same time), besides many other observations at the surface during the voyage. The readings were exact to one-200th of a degree Centigrade. The results will throw valuable light on the different currents of the Atlantic, especially

in the eastern part about the Canaries and Azores and in the domain of the Gulf Stream. Detailed observations with the Ekman current-metre were made in the Straits of Gibraltar and on the submarine slope south of the Azores. In the straits, interesting results were obtained as regards the limit between the upper or eastward-flowing current, and the lower or westward-flowing current, which was found to be at a depth of from 50 to 100 fathoms, according to the tide. The maximum velocity measured was about 5 knots, while velocities of from one to two knots were common, both in the upper and the lower current. By exposing photographic plates at varying depths, information was obtained as to the intensity of light beneath the waters of the Sargasso sea. The effect of light was clearly observable at 300 fathoms, and in a less degree at 500; but at 900 no influence of light was traceable. Only the blue rays were found to reach as low as 300 fathoms. The biological researches have yielded a rich harvest. Centrifugal action on the samples of water by means of a steam winch revealed the presence, in the warm waters of the Sargasso sea, of excessively minute pelagic plants, such as escape through the meshes of the finest silk nets. They were found in thousands in each litre of water down to about 50 fathoms, and the observations permitted the vertical distribution of the different species (many of them new) to be determined. These minute organisms belong to the order *Coccolithophoridæ*, the smallest species occurring chiefly in the warm seas, but two were found in some numbers even in the cold water on the Great Newfoundland bank. Deep-sea fishes and others of the larger organisms were obtained by tow-nets and trawls, used at varying depths, from the surface to 2000 fathoms. Many new species were brought to light, and pelagic fishes were found to exist at all depths, though scarce in the deepest layers. Off the west coast of Ireland, as many as 330 deep-sea fishes were caught in a single haul at 500 fathoms. The fauna of the bottom down to 2900 fathoms was investigated by a special trawl, but very few species were obtained from the greatest depths. The results of the temperature observations across the Gulf Stream to the south of the Great Banks were so interesting and unexpected, that the homeward route was altered so as to permit further investigations to be made, the visit to Iceland being therefore abandoned.

The Apparent Sinking of Ice in Lakes.—Letters have lately appeared in *Science* (June 3 and July 15, 1910) regarding the apparent sudden sinking of the surface ice in a lake during the process of disintegration. In the first letter Prof. Barnes, whose former studies of the subject of ice in rivers and lakes are well known, explains the appearance by supposing that the water beneath the ice gradually becomes warmer until it reaches the temperature of maximum density, considerably above the freezing point. This honeycombs the ice, but whereas in a river the effect of wind and current is to loosen the ice and carry it downstream, in a quiet lake it remains intact as a collection of vertical ice-needles, ready to topple over at the slightest touch; such collapse, with its characteristic rattling noise, occurring, in the writer's opinion, when the temperature of maximum density reaches the under surface of the ice. In commenting on this explanation, Prof. E. A. Birge, while completely agreeing with that part of it which refers to the supposed sinking, dissents from Prof. Barnes' theory as to the precedent warming of the water below the ice, showing that the observations made for many years in Lake Mendota, Wisconsin, in no way bear it out. Here the mean temperature of the lake water immediately after the disappearance of the ice never rises as high as that of maximum density. The layer of water just below the ice (derived from melting snow and ice) becomes rapidly warmer down to a slight depth, but below this the temperature falls gradually again. Prof. Birge sees no evidence

that the melting of the ice comes from the warm water below it, for unless the temperature of this were higher than 4° C. (39·2° Fahr.), there would be a non-conducting layer of colder water constantly between it and the ice. In Mendota a wind has always been the agent which has shattered the last hold of the crystals on each other.

GENERAL.

New Light on Sir Francis Drake's Last Voyage.—An important, and hitherto, it seems, unknown document relating to the last fatal voyage of Sir Francis Drake, has been brought to light by M. C. de la Roncière, who has described his find in the *Bulletin de Géographie Historique et Descriptive*, 1909, No. 3. It is an atlas of coast-sketches, such as were commonly made by the early navigators, preserved in the MS. department of the National Library in Paris. Nothing definite is known of the provenance of the atlas, which came to the Library with the Gaignières collection, though it seems probable that it had belonged to the Flemish chevalier H. F. Laurin de la Haye. The script and design of the vessels depicted showed it to date from the close of the sixteenth century, while an examination of the contents showed that the sketches exactly reproduced the itinerary of Drake in 1595-96, by the Canaries, Antilles, Curaçao, and the Isthmus of Panama. The painter of the sketches frequently speaks in the first person as having taken part in the events of the voyage, and the mention of Drake's death from dysentery, on the sketch depicting the spot at which it occurred, puts it beyond question that the drawings were made under the commander's supervision during the voyage.* They occupy twenty-two leaves, and the position whence they were made is shown in each (down to the fatal occurrence on January 28, 1595 (O.S.)) by a drawing of the ship. The character of this, and the fact that from the main-mast floats the admiral's flag, show it to have been Drake's own ship, the *Defiance*. It is interesting to note that the crew are shown as dressed in red uniforms, a practice then beginning to be adopted in the British navy. Besides the drawings of the coasts, there are a considerable number of explanatory notes by the draughtsman, and the record of Drake's death is made in these words: "This morninge, when the discription notid or taken of this lande, being the 28 of januarie, 1595, being Wedensdaie in the morninge, Sr Frauncis Dracke died of the bludie flix righte of the Ilande de Buena Ventura, som 6 leagues at see." The events of the voyage have been known from the journals kept by several members of the ill-fated expedition, a reprint of which was brought out by the Hakluyt Society in 1849. Reference may also be made to Corbett's 'Drake and the Tudor Navy,' 1898.

OBITUARY.

Trelawney William Saunders.

Trelawney William Saunders, "a recognized geographical authority of the highest rank," one of the oldest of our Fellows, died on July 22, 1910, at Newton Abbot, Devonshire, in his ninetieth year. He had been so long removed from active Fellowship by blindness and other calamities that some of his old acquaintances were astonished to hear that he had but now passed behind the veil.

Born at Plymouth, Devon, on April 16, 1821, he came to London at the age

* It is known that Drake took a draughtsman with him for a similar purpose, on his famous voyage of circumnavigation.

of eighteen to join the famous publishing house of Samuel Bagster & Sons, travelling as an "outside" by coach, and being nearly frozen to death when crossing Salisbury Plain in a snowstorm. It was doubtless his connection with this Bible house, together with his early association with the Plymouth Brethren, that gave him an intense and stimulating interest in Biblical geography.

He married, on October 1, 1844, Catherine Ann, second daughter of Commander Thomas Edward Knight, of the Royal Navy, and had issue six children, five of whom survive him.

In 1846 he joined our Society, and in the same year he took up his residence at No. 6, Charing Cross, then a stationer's shop. Here he began to sell maps, and was the first map-seller in London to issue a classified catalogue of the best foreign as well as English publications. In 1851 he produced a weather chart of the British Isles and the neighbouring coasts, and posted it daily at the Great Exhibition in Hyde Park; it is believed that it was this map that inspired the lad G. J. Symons to start a register of British rainfall. In 1852 he accepted Mr. Edward Stanford as a partner in his business, but the partnership was dissolved in the following year.

In 1853, Mr. Saunders published a book on 'The Asiatic Mediterranean and its Australian Port,' in which he advocated the establishment by the British Government of a settlement on the Gulf of Carpentaria which he proposed to call Port Flinders. In this scheme he had the support of his friend Captain Lort Stokes, R.N., who had surveyed the coasts and rivers of the Gulf when in command of H.M.S. *Beagle*.

In 1854 Mr. Saunders became an officer of our Society: he classified and arranged the books and maps in the new premises, acting temporarily as Librarian, and until 1857 filling the office of map-curator. In 1857 he designed a new educational establishment on a broad, liberal, national basis. It was to be established at Gnoll Castle, in the vale of Neath, which was purchased by the "Executive Council of Gnoll College," one of the objects being "the practical application of science to the public service." But although he was supported by such men as W. Bullock Webster and Lewis C. Hertslet, besides many local notabilities, the idea did not receive the encouragement it merited. One of the professors in this college was to be "Lecturer on Geography." On the failure of this scheme, which he took very much to heart, he returned to London and accepted an offer from Mr. Edward Stanford to organize and superintend a geographical department of his business. Here he edited the admirable series of Library maps of the great divisions of the globe, the best since the days of Aaron Arrowsmith—these were drawn and engraved for Mr. Stanford by Dr. Alexander Keith Johnston of Edinburgh; and here he produced the series of school wall maps that still hold their own in the teaching world. Here also he designed and superintended the construction of a detailed survey of London, plotted on the scale of 12 inches to 1 mile, and reduced and published on the scale of 6 inches to 1 mile—a beautiful and accurate piece of work, engraved on steel plates. In collaboration with the late Sir George Grove, he prepared the series of Biblical maps that were engraved for Dr. Smith's Atlas of Ancient Geography. He also designed and superintended the construction of a large model of Palestine and the Peninsula of Sinai for the Duke of Sutherland, which shows the depths of the seas as well as the heights of the land.

In the autumn of 1868 Mr. Saunders was invited to take charge of the extensive and valuable collection of maps, plans, charts, and memoirs that had been deposited at the India Office, and which had been allowed to fall into indescribable confusion. Here in the short space of six months he produced

order out of chaos. He wrote "A Catalogue of Manuscript and printed Reports: Field Books, Memoirs, Maps, etc., of the Indian Surveys," extending to 672 large quarto pages, which was published in 1878. This work was so successful that General Walker adopted it as a model for the catalogue of surveys in the head office in Calcutta. He had long seen the necessity of making the maps in the possession of the Government of India available to the general public, and it was due to his advocacy that agents were appointed for their sale. During his tenure of the office of Assistant Geographer to the Indian Office he enjoyed the inestimable advantage of collaborating with that veteran geographer Sir Clements Markham; with his able support Mr. Saunders produced the valuable critical series of maps of India that illustrated and illuminated the "Decennial Report" of 1882–83. The twelve maps in this report, with illustrative text and statistical tables, were afterwards published (1885) as an atlas.

In 1870 he published his famous 'Sketch of the Mountains and Rivers of India,' in which with remarkable geographical instinct he described a range of mountains on the north of the Indus-Sanpu valley which he called the Gangri mountains; he further developed this theory in the pages of the *Geographical Magazine* for July, 1877, and in a subsequent memorandum in 1882; and it is a great satisfaction to his friends to find that forty years afterwards, the remarkable travels and researches of Dr. Sven Hedin have confirmed his prophetic vision.

During Mr. Saunders' occupation of the post of Geographical Assistant to the India Office he devoted his scanty leisure in writing on Biblical geography, among other contributions being 'An Introduction to the Survey of Western Palestine,' which was issued by the Palestine Exploration Fund in 1881.

In 1885, after seventeen years' service, during which he had superintended the preparation of the many valuable maps issued from the India Office, he retired from the post he had so honourably filled. He was a regular attendant at our meetings and a frequent contributor to our discussions, which he often enlivened. He was also well known as a geographical expert at the meetings of the British Association, and at some of the learned societies. It was in part due to his strenuous advocacy that the British Association made its first departure from our shores and held a meeting at Montreal in 1884.

A man austere and stern of aspect, he had a very kind disposition, and was firm and sincere in his friendship; he was always ready, and would go far, to assist or advise any sincere inquirer on geographical subjects. Though not a draughtsman himself, he was an excellent teacher, and the works produced by his pupils under his direction are monuments to his ability. He was a geographer born, not made; he spent his strength and his substance in the pursuit of his favourite study, and it follows that he has left his daughters in somewhat straitened circumstances. It is a matter of sincere regret that his closing years should have been rendered desolate by loss of sight and loss of memory.

JOHN BOLTON.

CORRESPONDENCE.

An Antiquarian Find in Cape Colony.

SOME two years ago, when enlarging the boarding house at St. Mary's Cove, Kowie West, an iron-bound box containing papers sodden with water was unearthed, together with a little image in fragments. The exact spot is close to the public well which was dug by a party of soldiers camped there in about 1823. Mrs. Irving, a daughter of the original owner, the Hon. William Cock, remembers the fact of the well being dug, but cannot connect the image with any event in

THE KOWIE IMAGE.

her lifetime; her derivation of the name St. Mary's Cove is from her sister Mary. In former times the Kowie river entered the sea about half a mile east of its present mouth, and the lagoon wound westwards to St. Mary's Cove, which was known as the watering-place before 1820. Mr. Cock opened the mouth of the river on the west, and built retaining walls straightening the river's course, so that St. Mary's is now separated by about 150 yards of reclaimed ground from the estuary. Above the former eastern mouth there are the ruins of the old custom house, which are said to be on the site of a Portuguese fort and slaving station; the custom house, with its big cellars, is often mistaken for the original fort, but there is no doubt that all the buildings now above ground are modern.

The discovery of the image, however, has quickened the legend that the Portuguese used to raid the natives and carry them away as slaves; the Kaffirs only moved into this part in 1730, so that the captured natives must have been the original bushmen, of whom large numbers existed in 1775 under the rule of a king of their own, 'Kohla, between the Bushman's river and the St. Fish river.

The image was in fragments, but has been skilfully restored by Mr. F. Armstrong; it is certainly not the principal part of the statue, but only the supporting bracket; it is of plaster of Paris, very soft from long soaking, and was carved after being cast, and there are traces of its having been painted; there are holes where evidently a wire has passed through attaching the main image to the bracket. It seems possible that a date might be assigned to the little image by comparing it with similar figures, and should there be evidence enough to assign it to the seventeenth or eighteenth centuries, it will constitute a clue to the former occupancy of this wild shore.

Off the mouth of the Kowie there are the Fountain rocks, probably so named by the Portuguese because they were a landmark of the St. Mary Cove fountains, as similarly St. Croix island and the Hole-in-the-Wall off the Mutata river have been called Penedo das Fontes.

Ernest H. L. Schwarz,
Rhodes University College.

June 3, 1910.

The Sand-dunes of the Libyan Desert.

In the June number of the *Cairo Scientific Journal* (pp. 148–150) Dr. W. F. Hume has been kind enough to review a paper ("The Sand-dunes of the Libyan Desert") which I read before the Research Department of the Royal Geographical Society in January last, and which was published in the *Geographical Journal* for the following April.

There are two points in the review which appear to call for reply.

Firstly with regard to the map. On so small a scale (1 : 7,500,000) it is difficult to do more than show the geological deposits in broad outline, and I admit the strict accuracy of Dr. Hume's criticism that the words "Undulating desert of arenaceous deposits of post-Middle Eocene age," written across the northern part of the Libyan desert, attribute too great an importance to the sandy deposits. I would point out, however, that the map is not likely to prove misleading when read in conjunction with the text, in which the area in question is correctly described as *very largely* consisting of arenaceous deposits.

Secondly with regard to Dr. Hume's protest against a criticism of mine. He writes as follows:—

"I suggested in a former number of this journal whether it might not be possible for the impact of blown sand to cause such molecular re-arrangement as would lead to limestones becoming crystalline. This request for information as to a possibility has been raised by Mr. Beadnell to the rank of a theory. As I am unfortunately too familiar with crystalline limestones present in places where no such action could have caused their present structure, it is natural that I should protest against widening my question."

On reading the above, I looked up Dr. Hume's original paper, and herewith transcribe his exact words:—

"Striking, too, is the physical effect produced on the limestones, which have become hard and crystalline, indeed almost a marble, under the influence of the steady impact."

In face of these words, Dr. Hume's present contention that he was merely

making a suggestion and asking for information is inexplicable. The sentence amounts to an unreserved statement, and no one reading it could come to any other conclusion but that the writer was setting forth an established fact. He goes even further, and broaches the question whether similar physical changes might not be produced artificially on soft stones by some form of sand-blast.

Under the circumstances I do not think that Dr. Hume has any grounds of complaint against my very mild criticism, which was as follows:—

"It has even been suggested that under the impact of blown sand ordinary limestone may become hardened and be rendered crystalline; but, as I have stated elsewhere, until it can be shown that the crystalline limestones, which are of such common occurrence in the Libyan desert, bear some definite relation to the desert surface, and that a rock can withstand the wearing action of blown sand for a sufficient period to sustain internal physical alterations, the theory can hardly be expected to obtain credence."

H. J. Llewellyn Beadnell.

August 1, 1910.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Se'skab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alps. **Ellis.**

Alpine profile road book of Switzerland and adjacent portions of the Tyrol and the Italian Lake district. Comprising profiles of the roads, with gradients; notes on the passes; tables of distances and elevations. Compiled and edited by R. H. U. Ellis. London (for the Cyclists' Touring Club): T. Nelson & Sons, 1910. Size 4 × 7, pp. 148. *Profiles.* *Price 3s. 6d. net.* *Presented by the Publishers.*

This will prove a valuable help to cyclists in Switzerland.

Alps. **Whymper.**

The Valley of Zermatt and the Matterhorn: a guide. By Edward Whymper. (Pp. xiv. and 224.) Chamonix and the Range of Mont Blanc: a Guide. By the same.

(Pp. xiv. and 206.) London: J. Murray, 1910. Size 7½ × 5. *Maps and Illustrations. Price (each)* 3*s. net. Presented by the Publisher.*

Alps, Central. **Strutt.**

Conway and Coolidge's Climbers' Guides. The Alps of the Bernina west of the Bernina Pass. By E. L. Strutt. Two vols. London: T. Fisher Unwin, 1910. Size 5 × 3, pp. (vol. 1) xxiv. and 234; (vol. 2) xxiv. and 232. *Price (each vol.)* 10*s. net. Presented by the Publisher.*

Alps—Glaciation. *B.S.G. Italiana*, IV. 10 (1909): 1402–1410. **Marson.**

Nevai di circo e traccie carsiche e glaciali nel Gruppo del Cavallo, con quale nuovo contributo allo studio dell' antico ghiacciaio della Piave. Del prof. Luigi Marson. *Illustrations.*

Austria—Dalmatia. **Adamović.**

Vegetationsbilder (Karsten and Schenck) 7 (1909): Plates 19–24.

Vegetationsbilder aus Dalmatien. Von L. Adamović. *Illustrations.*

Austria—Seismology. **Conrad.**

M. Erdbeben-Komm., K.A.W. Wien, N.F. No. 36 (1909): pp. 24.

Die zeitliche Verteilung der in den österreichischen Alpen- und Karstländern gefühlten Erdbeben in den Jahren 1897 bis 1907. Von Dr. Viktor Conrad. (I. Mitteilung.) *Diagrams.*

Belgium. **Charriaut.**

Henri Charriaut. La Belgique moderne: une terre d'expériences. Paris: E. Flammarion, 1910. Size 7½ × 4½, pp. 390. *Price* 3 *fr.* 50. *Presented.*

Deals with the political, social, and economic aspects of Belgium. The effects of the dualism of race are dwelt upon, but there is no attempt to trace in detail the influence of geographical factors.

Belgium—Phytogeography. **Massart.**

Esquisse de la géographie botanique de la Belgique. Par Jean Massart. (Extrait du 'Recueil de l'Institut botanique Léo Errera,' Tome supplémentaire vii. bis.) Brussels: H. Lamertin, 1910. Size 11 × 7, pp. xii. 332. *Maps, Illustrations, and Diagrams; also separate 'Annexe' of Maps and Illustrations. Price* 21*s.*

An important work, bringing out the dependance of the plant formations on soil and other physical factors.

Germany—Lübeck. **Spethmann.**

Lübeck. Ein landeskundlicher Grundriss. Von Dr. Hans Spethmann. (Aus den Mitteilungen der Geographischen Gesellschaft und des Naturhistorischen Museums in Lübeck, 2. Reihe, Heft 24.) [Lübeck, 1910.] Size 10 × 7, pp. 40.

Germany—Relief. **Reinisch.**

Entstehung und Bau der deutschen Mittelgebirge. Von Dr. R. Reinisch. Leipzig: Dieterich, 1910. Size 9½ × 6½, pp. viii. and 206. *Sketch-maps and Sections. Price* 3*s.* 6*d.*

Discussion of one of the most important problems in the morphology of Germany.

Iceland. **Herrmann.**

Island in Vergangenheit und Gegenwart. Reise-Erinnerungen von Paul Herrmann. III. Teil: Zweite Reise quer durch Island. Leipzig: W. Engelmann, 1910. Size 10 × 7, pp. x. and 312. *Map and Illustrations. Price* 7*m. Presented by the Publisher.*

The first two parts have already been reviewed (vol. 32, p. 164).

Italy—Piedmont. **Ferrero.**

The Valley of Aosta: a descriptive and historical sketch of an Alpine Valley noteworthy in story and in monument. By Felice Ferrero. New York and London: G. P. Putnam's Sons, 1910. Size 8½ × 5½, pp. xvi. and 336. *Maps and Illustrations. Price* 7*s.* 6*d. net. Presented by the Publishers.*

Italy—Sicily. **Caico.**

Sicilian ways and days. By Louise Caico. London: J. Long, Ltd., 1910. Size 9 × 5½, pp. 280. *Illustrations. Price* 12*s.* 6*d. net. Presented by the Publisher.*

Italy—Sicily. **Olivier.**

En Sicile: guide du savant et du touriste. Sous la direction de Louis Olivier. Paris: E. Flammarion, [1910]. Size 7½ × 5, pp. x. and 668. *Maps and Illustrations. Price* 10 *fr.*

This is more than a mere guide-book of the ordinary type, as it supplies a systematic summary of our knowledge of the island on a scientific basis.

Rumania. **Stavenhagen.**

Rumanien in militärgeographischer Hinsicht. Von R. Stavenhagen. (Sonderabdruck aus Nr. 4 and 5 des Militär-Wochenblattes 1910.) Berlin, 1910. Size 10½ × 8, pp. 6.

Russia—Finland—Language. **Renfors.**

Marlborough's Self-taught Series. Finnish self-taught (Thimm's system), with phonetic pronunciation. By Agnes Renfors. London: E. Marlborough & Co., 1910. Size 7½ × 5, pp. 120. *Presented by the Publishers.*

Russia—Finland—Phytogeography. **Cajander.**

Acta S. Sc. Fennicæ **37** (1909): No. 5, pp. 224.

Beiträge zur Kenntnis der Vegetation der Alluvionen des nördlichen Eurasiens. Von A. K. Cajander. III. Die Alluvionen der Tornio- und Kemi-Thäler. *Maps.*

Spain. **Luffmann.**

Quiet days in Spain. By C. Bogue Luffmann. London: J. Murray, 1910. Size 9 × 5½, pp. xvi. and 318. *Price 8s. net. Presented by the Publisher.*

Spain—Historical. **Blázquez y Delgado-Aguilera.**

B.R.S.G. Madrid **51** (1909): 186–270.

Geografía de España in el siglo xvi. Discursos leídos ante la Real Academia de la Historia en la recepción pública del Sr. D. Antonio Blázquez y Delgado-Aguilera el día 16 de Mayo de 1909.

Spain—Mallorca. **Ludwig Salvator.**

Die Felsenfesten Mallorcas. Geschichte und Sage. [By H. I. H. the Archduke Ludwig Salvator.] Prague: H. Mercy Sohn, 1910. Size 9 × 6, pp. xviii. and 494. *Plans. Presented by the Archduke Ludwig Salvator.*

An interesting summary of present knowledge of the old rock-fortresses of Mallorca, which played so important a part in early history, followed by a detailed account of each of the three. The plans are from surveys by Don Guillermo Reynes.

Sweden—Heaths. *Ymer, Ts. Svenska S. G.* **29** (1909): 309–335. **Schager.**

De sydsvenska Ljunghedarna. Af Nils Schager. *Sketch-maps and Illustrations.*

On the heaths of Southern Sweden.

Switzerland—Geology. *Matériaux Carte géol. Suisse* **29** (1908): pp. 541–1025. **Rollier.**

Bibliographie géologique de la Suisse pour les annés 1770 à 1900. Seconde partie, L 1 (Hydrodynamique et Glacialisme) jusqu'à V (Reliefs géologiques). Par le Dr. Louis Rollier.

Turkey—Bosphorus and Dardanelles. **Hoernes.**

Sitzb. A.W. Wien **118** (Abtl. I.) (1909): 693–758.

Die Bildung des Bosporus und der Dardanellen. Von Rudolf Hoernes. *Plans and Diagrams.*

Noticed in the Monthly Record, April, p. 448.

United Kingdom—Canals. **Royal Commission.**

Royal Commission on Canals and Waterways. Vol. 9. Reports by Sir John Wolfe Barry and Partners on the cost of improving canal routes, to the Royal Commission appointed to enquire into and to report on the Canals and Inland Navigations of the United Kingdom. London: Wyman & Sons, 1910. Size 13 × 8½, pp. iv. and 216. *Map and Sections. Price 7s. 8d. Presented by the Royal Commission.*

United Kingdom—Dorset. **Salmon.**

Cambridge County Geographies (edited by F. H. H. Guillemard). Dorset. By Arthur L. Salmon. Cambridge: University Press, 1910. Size 7½ × 5, pp. x. and 154. *Maps and Illustrations. Price 1s. 6d. Presented by the Publishers.*

United Kingdom—Downs. *Geol. Mag.* V. **7** (1910): 49–57. **Clinch.**

The Sculpturings of the Chalk Downs of Kent, Surrey, and Sussex. By George Clinch. *Illustrations and Diagrams.*

United Kingdom—London District. **Woodward.**

Memoirs of the Geological Survey. England and Wales. The Geology of the London District. (Being the area included in sheets 1–4 of the special map of London.) By Horace B. Woodward. London, 1909. Size 9½ × 6, pp. viii. and 142. *Map, Sections, and Illustrations.*

United Kingdom—Place-names. **Hogan.**

Onomasticon Goedelicum locorum et tribuum Hiberniæ et Scotiæ: an index, with identifications, to the Gaelic names of places and tribes. By Edmund Hogan. Dublin: Hodges, Figgis & Co. (London: Williams & Norgate), 1910. Size 10 × 7½, pp. xvi. and 696. *Index-map. Price* 12*s.* 6*d. net. Presented by the Royal Irish Academy.*

Supplies identifications of the place-names occurring in Gaelic literature, arrived at by careful study, both of early documents and of previous labours in the same field.

United Kingdom—Scotland—Lakes. **Murray and Pullar.**

Bathymetrical Survey of the Scottish fresh-water lochs, conducted under the direction of Sir John Murray and Lawrence Pullar during the years 1897 to 1909. Report on the scientific results. Six vols. Edinburgh: Challenger Office, 1910. Size 9½ × 6, pp. (vol. 1) lviii. and 786; (vol. 2) lviii., 436, and 282; (vols. 3–4, *Maps only*). *Maps, Illustrations, Sections, and Diagrams. Price* £5 5*s. net. Presented by the Authors.*

United Kingdom—Scotland—Lakes. *P.R.S. Edinburgh* **30** (1910): 65–182. **West.**

A Further Contribution to a Comparative Study of the dominant Phanerogamic and Higher Cryptogamic Flora of Aquatic Habit in Scottish Lakes. By George West. *Illustrations.*

United Kingdom—Wales. *T.R.S. Edinburgh* **47** (1908–9): 17–56. **Jehu.**

The Glacial Deposits of Western Carnarvonshire. By Dr. T. J. Jehu. *Sketch-map, Illustrations, Diagrams, and Sections.*

United Kingdom—Wye. **Ellis.**

The Winding Course of the River Wye. By T. S. Ellis. Gloucester: John Bellows, 1910. Size 8½ × 5½, pp. 10. *Map. Presented by the Author.*

United Kingdom—Yorkshire—Vegetation. **Margerison.**

The Vegetation of some disused Quarries. The conquest of new ground by plants. By Samuel Margerison. Bradford, 1909. Size 8½ × 5½, pp. 52. *Sketch-map and Illustrations. Presented by the Author.*

Noticed in the Monthly Record for June (vol. 35, p. 717).

Western Europe—Historical. **Zimmer.**

Sitzb. K. Preuss. A.W. Berlin (1909): 363–400, 430–476, 543–580, 582–613.

Ueber direkte Handelsverbindungen Westgalliens mit Irland im Altertum und frühen Mittelalter. Von H. Zimmer.

ASIA.

Asia. **Bates.**

The Russian road to China. By Lindon Bates. London: Constable & Co., 1910. Size 8½ × 5½, pp. x. and 392. *Map and Illustrations. Price* 10*s.* 6*d. net. Presented by the Publishers.*

Central Asia—Tian-shan. **Gröber.**

Aus den Wissenschaftlichen Ergebnissen der Merzbacherschen Tian-Schan Expedition. Carbon und Carbonfossilien des nördlichen und zentralen Tian-Schan. Von Paul Gröber. (Aus den Abhandlungen der K. Bayer. Akademie der Wiss., II. Kl., XXIV. Bd., II. Abt.) München, 1909. Size 11½ × 9, pp. 339–384. *Illustrations. Presented by Dr. G. Merzbacher.*

China and Korea. **Cook.**

Cook's Handbook for tourists to Peking, Tientsin, Shan-hai-kwan, Mukden, Dalny, Port Arthur, and Seoul. London: T. Cook & Son; and Simpkin & Co., 1910. Size 7 × 5, pp. 116. *Maps, Plans, and Illustrations. Price* 3*s. net. Presented by Messrs. T. Cook & Son.*

Chinese Empire—Mongolia. **Hedley.**

Tramps in dark Mongolia. By John Hedley. London: T. Fisher Unwin, 1910. Size 9 × 5½, pp. xii. and 372. *Sketch-map and Illustrations. Price* 12*s.* 6*d. net. Presented by the Publisher.*

Eastern Asia. **Grew.**

Sport and travel in the Far East. By J. C. Grew. London: Constable & Co., 1910. Size 8½ × 5½, pp. xiv. and 264. *Illustrations. Price* 10*s.* 6*d. net. Presented by the Publishers.*

Eastern Asia—Handbook.

The all-rail route between the Far East and Europe. London: Christophers, 1910. Size 7 × 4½, pp. 138. *Sketch-map and Illustrations. Price* 2*s. net. Presented by the Publisher.*

A handbook for visitors to the Far East. The title is misleading, as only the last chapter deals with the railway route.

Ceylon—Roads.

Itinerary of the principal roads in Ceylon. Colombo: Government Printer, 1909. Size 9½ × 6, pp. vi. and 110. *Map. Presented by the Colonial Office.*

French Indo-China—Annam. **Vassal.**

On and off duty in Annam. By Gabrielle M. Vassal. London: W. Heinemann, 1910. Size 9 × 6, pp. xii. and 284. *Illustrations. Price* 10*s. net.*

A most readable account of experiences in Annam, by the wife of a French army doctor.

India—Burma. **Cocks.**

A short history of Burma. By S. W. Cocks. London: Macmillan & Co., 1910. Size 7 × 4½, pp. x. and 230. *Map and Illustrations. Price* 2*s. net. Presented by the Publishers.*

India—Central. **Luard and others.**

The Central India State Gazetteer Series. Vol 1, Gwalior State. Compiled by Captain C. E. Luard and Rai Sahib Pandit D. N. Sheopuri (4 parts). Vol. 2, Indore State. By Captain C. E. Luard and Major R. P. Dube. Vol. 3, Bhopal State. By Captain C. E. Luard and Munshi Kudrat Ali. Vol. 4, Rewah State. By Captain C. E. Luard and Pandit Janki Prasad. Vol. 5, Western States (Mālwā). By Captain C. E. Luard. (2 parts.) Vol. 6, Eastern States (Bundelkhand). By Captain C. E. Luard. (2 parts.) Calcutta, etc., 1907–9. Size 10 × 6½. (Total of work: 6 vols. in 11.) *Maps and Illustrations. Presented by the India Office.*

India—Cities. **Goës.**

Die indischen Grossstädte. Von Dr. Karl Goës. (Statistische und National-ökonomische Abhandlungen . . . herausgegeben von Dr. Georg von Mayr, Heft VII.) München: E. Reinhardt, 1910. Size 10½ × 7½, pp. 94. *Price* 3.50*m. Presented by the Publisher.*

Discusses the demographic characters of the Indian cities, as best affording an indication of the progress made by Western ideas in India.

India—Eastern Bengal and Assam. **Francklin.**

Journal of a route from Rajemehul to Gour, A.D. 1810–11. By Major William Francklin. [First printed for the Government of Eastern Bengal and Assam. Shillong, 1910.] Size 13 × 8½, pp. 22 [with type-written memorandum on the journal, 2 ll.]. *Presented by the India Office.*

Indian Ocean—Cocos-Keeling Islands. **Wood-Jones.**

Coral and atolls: their history, description, theories of their origin both before and since that of Darwin; the influence of winds, tides, and ocean currents on their formation and transformations, their present condition, products, fauna and flora. By F. Wood-Jones. London: Lovell Reeve & Co., 1910. Size 9 × 6, pp. xxiv. and 392. *Maps and Illustrations. Price* 24*s. net. Presented by the Publishers.*

Indo-China—Bibliography. **Brébion.**

Antoine Brébion. Bibliographie des voyages dans l'Indochine française du IX^e^ au XIX^e^ siècle. Saigon: F.-H. Schneider, 1910. Size 9 × 6, pp. vi., 300, and xliv. *Price* 7.50 *fr. Presented by the Author.*

Malay Archipelago—Dutch East Indies. **Cabaton.**

Antoine Cabaton. Les Indes néerlandaises. Paris: E. Guilmoto, [1910]. Size 9 × 5½, pp. viii. and 382. *Sketch-map. Price* 8 *fr. Presented by the Publishers.*

A valuable addition to the series of works on European Colonies in various parts of the world, brought out by the same publisher.

Russia—Siberia—Ethnology. **Bogoras.**

The Jesup North Pacific Expediton. Memoir of the American Museum of Natural History. Edited by Franz Boas. Vol. 8, Part 1. Chukchee mythology. By Waldemar Bogoras. New York: 1910. Size 13½ × 10½, pp. 1–198.

Turkey—Asia Minor—Archæology. **Garstang.**

The land of the Hittites: an account of recent explorations and discoveries in Asia Minor, with descriptions of the Hittite monuments. By Dr. John Garstang. London: Constable & Co., 1910. Size 9 × 5½, pp. xxiv. and 416. *Maps, Plans, and Illustrations. Price* 12*s.* 6*d. net. Presented by the Publishers.*

Turkey—Mesopotamia—Historical. **King.**

A history of Sumer and Akkad: an account of the early races of Babylonia from prehistoric times to the foundation of the Babylonian monarchy. [Being Part I. of A history of Babylonia and Assyria from prehistoric times to the Persian conquest.] By Leonard W. King. London: Chatto & Windus, 1910. Size 10 × 6½, pp. xxiv. and 380. *Map, Plans, and Illustrations. Price* 18*s. net.*

A learned work, summarizing the results of recent research on the early history of Babylonia.

AFRICA.

Africa. **Ghisleri.**

Atlante d'Africa . . . con notizie geografiche, economiche e statistiche . . . Dal Prof. Arcangelo Ghisleri. Bergamo, Istituto Italiano d'Arti Grafiche, 1909. Size 12 × 9, pp. 202. *Maps, Plans, Sections, and Diagrams. Price* 25 *lire. Presented by the Author.*

Africa—Zoogeography. **Boulenger.**

Catalogue of the freshwater fishes of Africa in the British Museum (Natural History). Vol. 1. By George Albert Boulenger. London: British Museum (Natural History), 1909. Size 11 × 7½, pp. xii. and 374. *Illustrations. Presented by the Trustees.*

Algeria—Kabylia. *Ann. G.* **18** (1909): 24–33. **Lespès.**

Le climat de la Kabylie du Djurdjura. Par le Prof. R. Lespès.

Algeria—Relief. *Ann. G.* **18** (1909): 328–340. **Gautier.**

La meseta sud-oranaise. Par E. F. Gautier. *Sketch-map and Sections.*

Belgian Congo. *B.S.G. Italiana* IV. **10** (1909): 888–908. **Piscicelli.**

Il paese dei Bango-Bango. Del capt. Maurizio Piscicelli. *Sketch-map and Illustrations.*

Belgian Congo—Mining. **Ball and Shaler.**

Mining Conditions in the Belgian Congo. (Congo Free State.) By Sydney H. Ball and Millard K. Shaler. (From the *Transactions of the American Institute of Mining Engineers*, March, 1910.) [Philadelphia, 1910.] Size 9 × 6, pp. 253–283. *Sketch-maps, Sections, Plans, and Illustrations.*

Belgian Congo—Phytogeography. **Gillet and Pâque.**

Annales du Musée du Congo Belge: Botanique. Serie V. Notes botaniques sur la région du Bas- et Moyen-Congo. Fascicule 1: Plantes principales de la région de Kisantu; leur nom indigène, leur nom scientifique, leurs usages. Par J. Gillet et E. Pâque. Brussels, 1910. Size 15 × 11, pp. 120. *Illustrations.*

East Africa. **Younghusband.**

Glimpses of East Africa and Zanzibar. By Ethel Younghusband. London: J. Long, Ltd., 1910. Size 9 × 5½, pp. 320. *Illustrations. Price* 12*s.* 6*d.*

Impressions and experiences of a lady who knows East Africa by long residence. The book will be useful to intending visitors.

Egypt—Ethnology. **Sourdille.**

Hérodote et la réligion de l'Égypt. Comparaison des données d'Hérodote avec les données Égyptiennes. Par Camille Sourdille. Paris: E. Leroux, 1910. Size 10 × 6½, pp. xvi. and 420. *Presented by the Author.*

Egypt—Historical. **Sourdille.**

La durée et l'étendue du voyage d'Hérodote en Egypte. Par Camille Sourdille. Paris: E. Leroux, 1910. Size 10 × 6½, pp. 260. *Map. Presented by the Author.*

Morocco—Riff. *Petermanns M.* **55** (1909): 293–295, 340–341. **Hübner.**

Militärgeographische Skizze des Rifs. Von Oberstleut. Hübner. *Maps and Plan.*

North-West Africa. *Z. Ges. E. Berlin* (1909): 676–688. **Frobenius.**

Kulturgeographische Betrachtung Nordwest-Afrikas. Von Leo Frobenius.

Sahara—Tidikelt. *B.S.G. Oran* **29** (1909): 185–216, 311–366, 419–480. **Voinot.**

Le Tidikelt. Etude sur la Géographie, l'Histoire et les Mœurs du pays. Par L. Voinot. *Maps, Plans, and Illustrations.*

South Africa—Historical. **Cory.**

The rise of South Africa: A history of the origin of South African colonization and of its development towards the East from the earliest times to 1857. By G. E. Cory. Vol. 1, From the earliest times to the year 1820. London: Longmans & Co., 1910. Size 9 × 6, pp. xxii. and 420. *Map, Plans, and Illustrations. Price* 15*s.*

Attention is almost entirely focussed on the history of the Eastern province, which is treated in unusual detail. Three more volumes are to follow.

South Africa—Historical. **Theal.**

History and Ethnography of Africa South of the Zambesi, from the settlement of the Portuguese at Sofala in September, 1505, to the conquest of the Cape Colony by the British in September, 1795. By Dr. George McCall Theal. Vols. 2 and 3. London: Swan, Sonnenschein & Co., 1909–10. Size 9 × 5½, pp. (vol. 2) xx. and 524; (vol. 3) xiv. and 500. *Maps. Price* (*each vol.*) 7*s.* 6*d. Presented by the Publishers.*

Sudan—Bornu. **Schultze.**

Das Sultanat Bornu, mit besonderer Berücksichtigung von Deutsch-Bornu. Von Dr. Arnold Schultze. Essen: G. D. Baedeker, 1910. Size 9½ × 6½, pp. iv. and 136. *Maps. Price* 4*m.*

A useful compilation, summarizing present knowledge.

Sudan—Lake Chad. **Tilho.**

Republique française: Ministère des Colonies. Documents scientifiques de la Mission Tilho (1906–1909). Tome I. Paris: Imprimerie Nationale, 1910. Size 11 × 7, pp. lx. and 412. *Maps, Illustrations, and Diagrams; also Maps in separate case, Nos.* 1–8. *Presented by Captain J. Tilho.*

This important publication will be specially noticed.

West Africa. *G.Z.* **15** (1909): 620–641, 684–701. **Müller.**

Regenverteilung, Pflanzendecke und Besiedlung Ober-Guineas und des westlichen Sudan. Von Rudolf Müller. *Sketch-map and Diagrams.*

West Africa—Ethnology. *Globus* **97** (1910): 1–8, 25–29. **Tessmann.**

Verlauf und Ergebnisse der Lübecker Pangwe-Expedition. Nach einem Bericht, erstattet der Gesellschaft zur Beförderung gemeinnütziger Tätigkeit zu Lübeck. Von Günther Tessmann. *Map and Illustrations.*

NORTH AMERICA.

Alaska. **Powell.**

Trailing and camping in Alaska. By Addison M. Powell. London: Hurst & Blackett, 1910. Size 8½ × 5½, pp. 14 and 380. *Illustrations. Price* 7*s.* 6*d. net.*

An excellently illustrated popular narrative of adventure.

Canada—British Columbia—Ethnology. **Boas.**

The Jesup North Pacific Expedition. Memoir of the American Museum of Natural History. Vol. 5, Part II. The Kwakiutl of Vancouver Island. By Franz Boas. *Illustrations.* New York: 1909. Size 13½ × 10½, pp. 301–522.

Canada—Manitoba. **Bryce.**

Lord Selkirk's Colonists: the romantic settlement of the pioneers of Manitoba. By Dr. George Bryce. London: S. Low & Co., [1910]. Size 8½ × 5½, pp. 328. *Plan and Illustrations. Price* 7*s.* 6*d. net.*

Canada—Quebec—Historical. **Le Clercq and Ganong.**

The Publications of the Champlain Society. Vol. 5, New relation of Gaspesia; with the customs and religion of the Gaspesian Indians. By Father Chrestien Le Clercq. Translated and edited . . . by William F. Ganong. Toronto: The Champlain Society, 1910. Size 10 × 6½, pp xvi. and 452. *Facsimile Maps and Illustrations. Purchased.*

Translation, under the capable editorship of Dr. Ganong, of an early work (1691) on the country and people of Gaspé, the portion of Southern Quebec running out into the Gulf of St. Lawrence.

Saint Lawrence. **Johnson.**

The picturesque St. Lawrence. New York (London: Macmillan & Co.), 1910. Size 7 × 4½, pp. xiv. and 254. *Illustrations. Price* 3*s. net. Presented by the Publishers.*

CENTRAL AND SOUTH AMERICA.

Argentine—Historical. ———

Ponce de Leon: the rise of the Argentine republic. By an Estanciero. (New edition.) London: T. Werner Laurie, 1910. Size 9½ × 6, pp. x. and 436. *Price* 12*s.* 6*d. net. Presented by the Publisher.*

Peru—Historical. **Gutiérrez.**

Colección de libros y documentos referentes á la historia de América. Tomo X. Historia de las guerras civiles del Perú (1544–1548), y de otros sucesos de las Indias. Por Pedro Gutiérrez de Santa Clara. Tomo 4. Madrid: V. Suárez, 1910. Size 8 × 5, pp. 574. *Price* 7*s.* 6*d.*

South America. **Domville-Fife.**

The great States of South America: a concise account of their condition and resources, with the laws relating to Government concessions. By Charles W. Domville-Fife. London: G. Bell & Sons, 1910. Size 8½ × 5½, pp. xvi. and 236. *Maps and Illustrations. Price* 12*s.* 6*d. net. Presented by the Publishers.*

AUSTRALASIA AND PACIFIC ISLANDS.

New Zealand—Southern Islands. **Chilton.**

The Subantarctic Islands of New Zealand. Reports on the geophysics, geology, zoology, and botany of the islands lying to the south of New Zealand, based mainly on observations and collections made during an expedition in the Government steamer *Hinemoa* (Captain J. Bollons) in November, 1907. Edited by Chas. Chilton. Published by the Philosophical Institute of Canterbury. 2 vols. Wellington (London: Dulau & Co.), 1909. Size 11 × 8½, pp. xxxvi. and 848. *Map and Illustrations. Price* 42*s. net. Presented by the Publishers.*

Queensland—Ethnology. **Mathew.**

Two representative tribes of Queensland; with an inquiry concerning the origin of the Australian race. By John Mathew. With an introduction by Dr. A. H. Keane. London: T. Fisher Unwin, 1910. Size 7½ × 5½, pp. xxiv. and 256. *Sketch-map and Illustrations. Price* 5*s. net. Presented by the Publisher.*

MATHEMATICAL GEOGRAPHY.

Cartography—International Conference. ———

International Map Committee. Resolutions and proceedings of the International Map Committee assembled in London, November, 1909. London: Harrison & Sons, 1910. Size 13 × 8½, pp. 24. [Also in French and German.] *Index-maps. Price* 2*s.*

See article in the August number.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Geology. **Gregory.**

Geology. By J. W. Gregory. (Dent's Scientific Primers. Edited by J. Reynolds Green.) London: J. M. Dent & Sons, [1910]. Size 6½ × 4½, pp. 140. *Sections and Illustrations. Price* 1*s. net. Presented by the Publishers.*

Geology. **Haug.**

Emile Haug. Traité de Géologie. II. Les périodes géologiques (Fascicule 2). Paris: A. Colin, [1910]. Size 10 × 6½, pp. 929–1396. *Sketch-maps, Illustrations, and Sections. Price* 10 *fr. Presented by the Publisher.*

The earlier volumes were reviewed in vols. **31** (p. 668) and **34** (p. 80).

Meteorology. **Moore.**

Descriptive meteorology. By Dr. Willis L. Moore. New York and London: D. Appleton & Co., 1910. Size 9½ × 6½, pp. xviii. and 344. *Maps, Illustrations, and Diagrams. Price* 12*s.* 6*d. net.*

The author's position as head of the U.S. Weather Bureau is a guarantee that this work has been written with full knowledge of the subject.

Physical Geography. **Herbertson.**

The Oxford Geographies (edited by A. J. Herbertson). A physiographical introduction to geography. By A. J. Herbertson. Oxford: Clarendon Press, 1910. Size 7½ × 5, pp. 120. *Maps and Diagrams. Price* 1*s.* 6*d. Presented by the Publishers.*

Physical Geography. **Tarr and Von Engeln.**

A laboratory manual of physical geography. By Prof. R. S. Tarr and O. D. von Engeln. New York [London: Macmillan & Co.], 1910. Size 9½ × 8, pp. xviii. and 362. *Maps and Illustrations. Price* 6*s. Presented by the Publishers.*

Phytogeography. **Koch.**

Beiträge zur Kenntnis der Höhengrenzen der Vegetation im Mittelmeergebiete. Von Dr. Max Koch. Halle a. S.: C. A. Kaemmerer & Co., 1910. Size 9 × 6, pp. x. and 310. *Diagrams. Price* 6*m. Presented by the Publishers.*

Volcanoes. **Haas.**

Unterirdische Gluten. Die Natur und das Wesen der Feuerberge im Lichte der neuesten Anschauungen für die Gebildeten aller Stände in gemeinverständlicher Weise dargestellt von Dr. Hippolyt Haas. Berlin: A. Schall, 1910. Size 9½ × 6½, pp. viii. and 316. *Illustrations and Sections. Price* 8*m.*

A summary of the results of recent research on volcanic phenomena.

Zoogeography—Abysmal fauna. **Monaco.**

B.I. Océanogr. Monaco, No. 137 (1909): pp. 16.

La pêche dans les abîmes. Par S. A. S. le Prince Albert Ier de Monaco.

Deals with methods of capture.

Zoogeography—Eel. **Schmidt.**

Meddelelser Komm. Havundersøgelser, Fiskeri **3** (1909): No. 7, pp. 46.

On the distribution of the fresh-water eels (*Anguilla*) throughout the world. I. Atlantic Ocean and adjacent regions: a biogeographical investigation. By Johs. Schmidt. *Map.*

Zoogeography—Mosquitoes. **Theobald.**

A monograph of the Culicidæ, or mosquitoes. Mainly compiled from collections received at the British Museum. By Fred V. Theobald. Vol. 5. London: British Museum (Natural History), 1910. Size 8½ × 5½, pp. xvi. and 646. *Illustrations. Price* 25*s. Presented by the Trustees, British Museum (Natural History).*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Commercial. **Andree.**

Karl Andrees Geographie des Welthandels, vollständig neu bearbeitet von einer Anzahl von Fachmännern und herausgegeben von Dr. Franz Heiderich und Dr. Robert Seiger. I. Band. Frankfurt a. M., H. Keller, [1909–] 1910. Size 10 × 7, pp. xii. and 952. *Portrait and Maps. Price* 15*s.*

Commercial—Cables. **Margerie.**

Maxime de Margerie. Le réseau anglais de cables sous-marins. Paris: A. Pedone, [1910]. Size 10 × 6½, pp. 204. *Sketch-maps. Presented by the Author.*

Economic—Iron. **[Andersson.]**

The iron ore resources of the world: an inquiry made upon the initiative of the Executive Committee of the XI. International Geological Congress, Stockholm, 1910; with the assistance of Geological Surveys and mining geologists of different countries. Edited by the General Secretary of the Congress. Two vols. Stockholm: Lithographic Institute of the General Staff, 1910. Size 11 × 8½, pp. lxxx. and 1068. *Maps, Illustrations, and Sections; also separate Atlas* (*size* 19½ × 13½). *Price* £3.

Valuable as embodying a large amount of information supplied by experts from all parts of the world.

Ethnology—Arts. **Wilke.**

Darstellungen über früh- und vorgeschichtliche Kultur,- Kunst- und Völkerentwicklung. Herausgegeben von Prof. Dr. Gustaf Kossinna. 1. Heft. Spiral-Mäander-Keramik und Gefässmalerei: Hellenen und Thraker. Von Dr. Georg Wilke. Würzburg: C. Kabitzsch, 1910. Size 10½ × 7, pp. 84. *Illustrations. Price* 4*m.* 50. *Presented by the Publisher.*

Ethnology—Industries. **Kimakowicz-Winnicki.**

Darstellungen über früh- und vorgeschichtliche Kultur-, Kunst-, und Völkerentwicklung, herausgegeben von Prof. Dr. Gustaf Kossinna. 2. Heft. Spinn- und

Webewerkzeuge: Entwicklung und Anwendung in vorgeschichtlicher Zeit Europas. Von M. von Kimakowicz-Winnicki. Würzburg: C. Kabitzsch, 1910. Size 10½ × 7, pp. 70. *Illustrations. Price* 4*m.* 50. *Presented by the Publishers.*

GENERAL.

Adventure. **Hyatt.**

The diary of a soldier of fortune. By Stanley Portal Hyatt. London: T. Werner Laurie, [1910]. Size 9 × 5½, pp. viii. and 360. *Illustrations. Price* 12*s.* 6*d. net. Presented by the Publisher.*

British Empire—Petroleum. **Henry.**

Oil fields of the Empire: a survey of British Imperial petroleum questions and a comprehensive technical description of the oil fields of Trinidad and Newfoundland. By J. D. Henry. London: Published by the Author, [1910]. Size 10½ × 7½, pp. xxx. and 280. *Maps and Illustrations. Price* 18*s. Presented by the Author.*

Education—Text-book. **Webb.**

A systematic geography of Asia. By George William Webb. London: Methuen & Co., 1910. Size 7½ × 5, pp. viii. and 100. *Sketch-maps. Price* 1*s. Presented by the Publishers.*

Geography—Text-book. **Heaton.**

The senior scientific geography. By Ellis W. Heaton. London: Ralph, Holland & Co., [1910]. Size 7½ × 5, pp. 862. *Maps and Diagrams. Price* 5*s. net. Presented by the Publishers.*

Geography—Text-book. **Mackinder.**

Distant lands: an elementary study in geography. By H. J. Mackinder. London: G. Philip & Son, [1910]. Size 7½ × 5, pp. xvi. and 296. *Maps and Illustrations. Price* 2*s. Presented by the Publishers.*

Language. **O'Connor.**

Marlborough's Travellers' Esperanto Manual of Conversation. By J. C. O'Connor. London: E. Marlborough & Co., 1910. Size 6½ × 3½, pp. 78. *Price* 1*s. Presented by the Publishers.*

Year-book. **Haack.**

Geographen-Kalendar . . . herausgegeben von Dr. Hermann Haack. 8. Jahrgang, 1910. Gotha: J. Perthes, 1910. Size 6½ × 4, pp. xxx. and 738. *Map and Portrait. Price* 6*m.*

Year-book. **Keltie and Renwick.**

The Statesman's Year-Book: statistical and historical annual of the states of the world for the year 1910. Edited by Dr. J. Scott Keltie, with the assistance of I. P. A. Renwick. London: Macmillan & Co., 1910. Size 7 × 4½, pp. civ. and 1404. *Maps. Price* 10*s.* 6*d. net. Presented by the Publishers.*

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Austria. **Freytag.**

G. Freytag's Ausflugskarten mit farbigen Wegmarkierungen, vollständigem Ausflugsverzeichnis und Angabe der Entfernungen. Scale 1 : 100,000 or 1 inch to 1·6 stat. mile. Sheets: iv. Schöpflgebiet: ix. Bucklige Welt und Wechselgebiet; xvii. Wachau. Vienna and Leipzig: G. Freytag & Berndt, [1910]. *Price* 40 *heller each sheet. Presented by the Publishers.*

Austria. **Freytag.**

G. Freytag: Innsbruck und Umgebung. Scale 1 : 150,000 or 1 inch to 2·3 stat. miles. Plan von Innsbruck. Scale 1 : 15,000 or 4·2 inches to 1 stat. mile. Vienna and Leipzig: G. Freytag & Berndt, [1910]. *Price* 50 *pf. Presented by the Publishers.*

A coloured plan of Innsbruck, and another of its environs, showing relief by a combination of shading contours and colour-tinting. The two are folded in one cover, and should be useful to tourists and others visiting the place.

British Isles—England and Wales. **Ordnance Survey.**

Sheets published by the Director-General of the Ordnance Survey, Southampton, from July 1 to 31, 1910.

Diagram of England and Wales, 17 miles to 1 inch.
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Europe. **Freytag.**

G. Freytag's Automobil- und Radfahrer-Karten. Scale 1 : 300,000 or 1 inch to 4·7 stat. miles. Sheets: 20, Brünn; 29, Südtirol und Oberitalien. Vienna and Leipzig: G. Freytag & Berndt, [1910]. *Price* 1.35*m. each sheet. Presented by the Publishers.*

Two sheets of a useful map of Central Europe specially prepared for motorists. Roads are clearly marked and their character indicated, while other information is given in symbols. There is no hill shading, but the relative steepness of the road is indicated by an arrangement of colours.

Europe. **Freytag.**

G. Freytag's Automobil- Routenkarte von Mittel-Europa. Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. Vienna and Leipzig: G. Freytag & Berndt, [1910]. *Price* 2.50*m. Presented by the Publishers.*

Germany. **K. Sächs. Generalstabes.**

Karte des Deutschen Reiches. Herausgegeben von der Abteilung für Landesaufnahme des Königl-Sächs. Generalstabes. Scale: 1 : 100,000. Sheets: (Kupferdruckausgabe) 414, Zeitz; 415, Borna. Dresden: G. J. Kaufmann, 1909. *Price* 1.50*m. each sheet.*

Germany. **Ministerium der Offentlichen Arbeiten.**

Uebersichts-Karte der Verwaltungs-Bezirke der Konigl. Preuss. Eisenbahn-Direktionen und der Königl. Preuss. u. Grossherzl. Hess. Eisenbahn-Direktion in Mainz. Bearbeitet im Ministerium der Öffentlichen Arbeiten. Scale 1 : 1,000,000 or 1 inch to 15·8 stat. miles. 4 sheets. Berlin: Max Pasch, 1910.

A new edition of an official map of Germany, showing railways and railway systems to January of the present year. The railways in the environs of important cities and towns are shown as insets on enlarged scales.

Russia. **Ministry of Ways of Communication, St. Petersburg.**

Map of the Rail, Road, and Waterways of Communication of European Russia. Scale 1 : 1,680,000 or 1 inch to 26·5 stat. miles. 9 sheets. St. Petersburg: Ministry of Ways of Communication, 1909.

A useful map of European Russia, showing railways, principal roads, telegraphs, navigable waterways, ports, and other information connected with communications. Crown and other lands are indicated by shades of green. Inset plans are given of the railways in the neighbourhood of the principal cities and towns. The map is clearly drawn and printed, and contains altogether quite a large amount of information.

AFRICA.

Egypt. **Survey Department, Giza.**

Topographical map of Egypt. Scale 1 : 50,000 or 1·3 inch to 1 stat. mile. Sheets: N.W. V.–IV. El Ghiata; V.–V. Ikingi Mariut; V.–VI. Bahig; V.–VII. Hammam; VI.–VI. Mellaha. Giza: Survey Department, 1910. *Presented by the Director-General, Survey Department, Giza.*

Egypt. **Survey Department, Giza.**

Topographical map of Egypt. Scale 1 : 10,000 or 6·5 inches to 1 stat. mile. Sheets: N.W. 17–2, Mudiria Menufia; S.E. 136–38, 39, and 40; 137–40; 138–39, 40, 41; 139–40, 41; 140–40, 41; 141–39, 40, Mudiria Aswan. Giza: Survey Department, 1910. *Presented by the Director-General, Survey Department, Giza.*

Nigeria. **Beverley.**

Southern Nigeria: Central and Eastern Provinces. Compiled by Captain W. H. Beverley, Intelligence Officer. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. 10 sheets. London: Edward Stanford, 1910. *Price* £1.

This is an enlargement of Captain Beverley's map on the scale of 1 : 500,000, which was noticed in the *Geographical Journal* for May last.

Rhodesia. **Clevely.**

Map of Rhodesia. Compiled by A. J. Clevely. Scale 1 : 760,320 or 1 inch to 12 stat. miles. 2 sheets. Ilford: A. J. Clevely, 1910. *Price* £1 1*s.*

An outline map, without hill shading, showing land and mining properties in colours. Southern Rhodesia is taken, by permission, from the 1 : 500,000 map recently issued by the War Office. North-Western and North-Eastern Rhodesia, given as an inset on a smaller scale (1 : 3,250,000), have been drawn from the latest information, although little detail has been attempted.

AMERICA.

Canada. **Department of the Interior, Ottawa.**

Sectional map of Canada. Scale 1 : 190,080 or 1 inch to 3 stat. miles. Sheets: 15, Lethbridge, revised to February 15, 1910; 16, Milk River, revised to February 22, 1910; 19, Willowbunch, March 29, 1910; 66, Medicine Hat, revised to January 14, 1910; 67, Maple Creek, March 8, 1910; 113, Spillimacheen, revised to February 16, 1910; 164, Morley, revised to April 18, 1910; 220, Nut Mountain, revised to February 14, 1910; 314, St. Ann, revised to April 13, 1910; 315, Edmonton, revised to December 10, 1909. Ottawa: Department of the Interior, Topographical Surveys Branch, 1909–10. *Presented by the Department of the Interior, Ottawa.*

Mexico. **National Railways of Mexico.**

Map of the National Railways of Mexico. Scale 1 : 3,150,000 or 1 inch to 49·7 stat. miles. London: National Railways of Mexico, 1910. *Presented by E. J. Bray, Esq., General European Agent, National Railways of Mexico.*

A diagrammatic sketch-map showing clearly the various systems of national railways of Mexico in different colours. An inset is given, on an enlarged scale, of the railways in the vicinity of the city of Mexico and Vera Cruz. The map is mounted on rollers and varnished.

United States. **U.S. Geological Survey.**

Topographic Atlas of the United States. Scale 1 : 31,680 or 2 inches to 1 stat. mile. Sheets: Carbondale, Cal.; Clay, Cal.; Cosumnes, Cal.; Florin, Cal.; Goose Creek, Cal.—Scale 1 : 62,500 or 1·013 inch to 1 stat. mile. Sheets: Atlanta, Tex.-Ark.-La.; Bellefonte, Pa.; Central City, Ky.; Continental, Ohio; Defiance, Ohio; Earlington, Ky.; Elk Grove, Cal.; Fairfield, Pa.; Hartford, Ky.; Herrin, Ill.; Lancaster, Ohio; Lisbon, Ohio; Logan, Ohio; Luther, Okla.; McClure, Ohio; Milford, Mich.; Milo, Iowa; Newark, Ohio; New Boston, Tex.; Perkins, Okla.; Rockford, Minn.; Thornville, Ohio; Thurston, Ohio; Watertown, N.Y.; West Frankfort, Ill.; Whitesville, Ky.; Winnepesaukee, N.H.; Zanesville, Ohio.—Scale 1 : 125,000 or 1·9 inch to 1 stat. mile. Sheets: Austin, Tex.; Gallina, N. Mex.; Garden Valley, Idaho; Gross Ventre, Wyo.; Livermore, Colo.; Llano, Tex.; Sapphire, Mont.; Tuskahoma, Okla.; Winding Stair, Okla. Washington: Department of the Interior, U.S. Geological Survey, 1909–10. *Presented by the Director, U.S. Geological Survey.*

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during June, 1910. *Presented by the Hydrographer, Admiralty.*

New Charts—No. 2407, Scotland, west coast: Little Loch Broom, 3*s.* 3582, Newfoundland: Bay of Exploits, Sheet IV. (north-east), 5*s.* 2778, River St. Lawrence above Quebec: St. Antoine to Lotbinière, 4*s.* 2789*a*, River St. Lawrence above Montreal: Lachine rapids to Cascades point, including Lake St. Louis, 3*s.* **New Plans and Plans added.** No. 1806, Africa, west coast, Great Fish bay to Walfisch bay. New plan: Swakopmund road, 3*s.* 2196, Celebes. Sketch plans of anchorages in the southern part of Celebes. New Plan: Labuandata bay, 2*s.*

949, Ports in the Philippine islands. New Plan: Port Kanoan, 2*s*. 1508, Anchorages in the New Hebrides islands. Plans added: Nogugu anchorage. Lama Langa, 2*s*. **New Editions**—No. X–3, Mooring and Manœuvring Board, 2*s*. 6*d*. 3281, England, south coast: Portsmouth harbour, mooring ground, 3*s*. 915, Wales, west coast: Pembroke reach, 3*s*. 1630, England, east coast: Orfordness to Blakeney, 4*s*. 1543, England, east coast: Yarmouth and Lowestoft roads, 4*s*. 1407, Scotland, east coast: St. Abbs head to Aberdeen, 3*s*. 1481, Scotland, east coast: River Tay, 3*s*. 1118*a*, Scotland, north coast: The Shetland islands, Sheet I., 3*s*. 1118*b*, Scotland, north coast: The Shetland islands, Sheet II., 3*s*. 1753, Ireland, east coast: Belfast lough, 3*s*. 1872, North sea: Calais to the River Schelde entrance, 3*s*. 548, South America, east coast: Maldonado bay, 2*s*. 572, British Columbia: Constance cove, 2*s*. 922, British Columbia: Burrard inlet, 3*s*. 2837*a*, Persian gulf: eastern sheet, 3*s*. 753, Entrance of the Persian gulf, 3*s*. 38, Baluchistan: Maskat to Karáchi, 3*s*. 928, Sulu archipelago, 3*s*. 3555, Philippine islands: Danao river, and approaches, 2*s*. 967, Philippine islands: Palawan island, 3*s*. 3026, China, south coast: Macao to Pedro Blanco, 3*s*. 2894, China, north coast: Liau river, 3*s*. 3109, Japan: Yokohama bay, 2*s*. 1670*b*, Australia, east coast: Moreton bay, southern portion, 3*s*.

Atlantic, North. **U.S. Weather Bureau.**

Meteorological chart of the North Atlantic Ocean, September, 1910. Washington: Department of the Interior, U.S. Weather Bureau, 1910. *Presented by the U.S. Weather Bureau.*

Atlantic, North, and Mediterranean. **Meteorological Office.**

Monthly Meteorological Charts of the North Atlantic and Mediterranean, August, 1910. London: Meteorological Office, 1910. *Price 6d. each. Presented by the Meteorological Office.*

Atlantic, South. **U.S. Hydrographic Office.**

Pilot chart of the South Atlantic Ocean, September, October, and November, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Atlantic, South. **U.S. Weather Bureau.**

Meteorological chart of the South Atlantic Ocean, Season—September, October, and November, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Burma. **Hunton.**

Rangoon Harbour (moorings, wharves, etc.), surveyed July to September, 1909, by A. S. Hunton, River Surveyor. Scale 1:3600 or 17·6 inches to 1 stat. mile. Rangoon: Commissioners for the Port of Rangoon. *Presented by H. G. G. Ashton, Esq., Deputy Conservator of the Port of Rangoon.*

A very complete survey of Rangoon harbour, with lines of soundings at close intervals, which are given in feet and reduced to the zero of Brooking Street tide-gauge.

Indian Ocean. **Meteorological Office.**

Monthly Meteorological Charts of the Indian Ocean, August, 1910. London: Meteorological Office, 1910. *Price 6d. each. Presented by the Meteorological Office.*

Pacific, North. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific Ocean, September, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

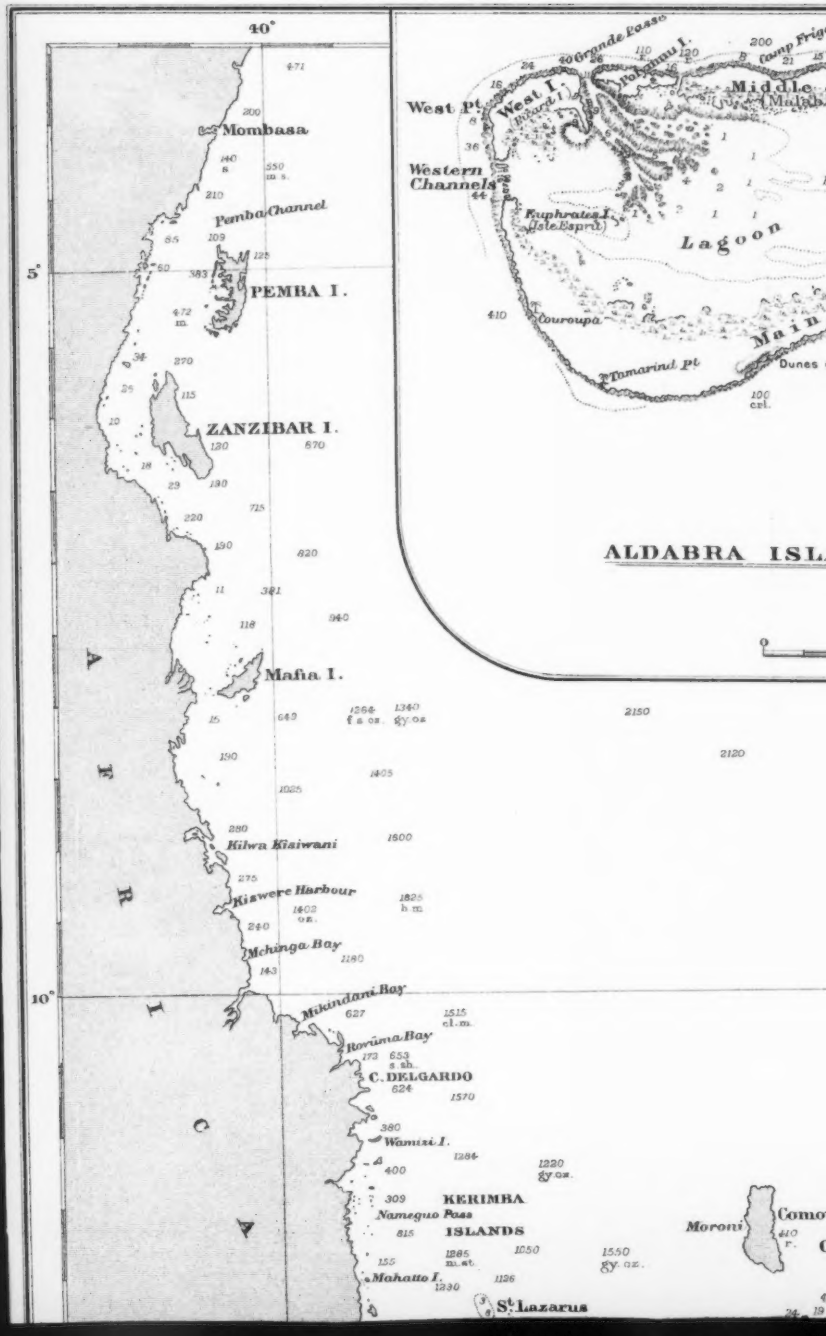
Pacific, North. **U.S. Weather Bureau.**

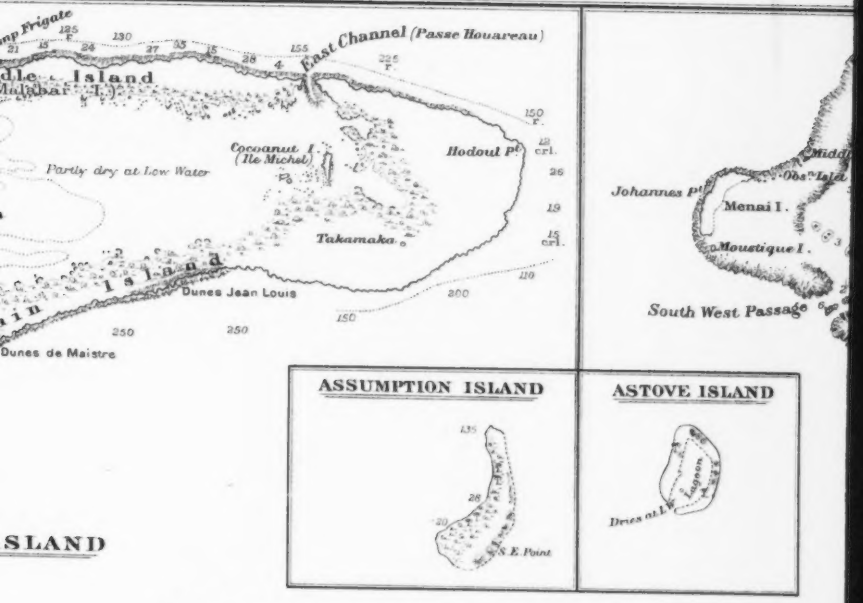
Meteorological chart of the North Pacific Ocean, September, 1910. Washington: Department of Agriculture, U.S. Weather Bureau, 1910. *Presented by the U.S. Weather Bureau.*

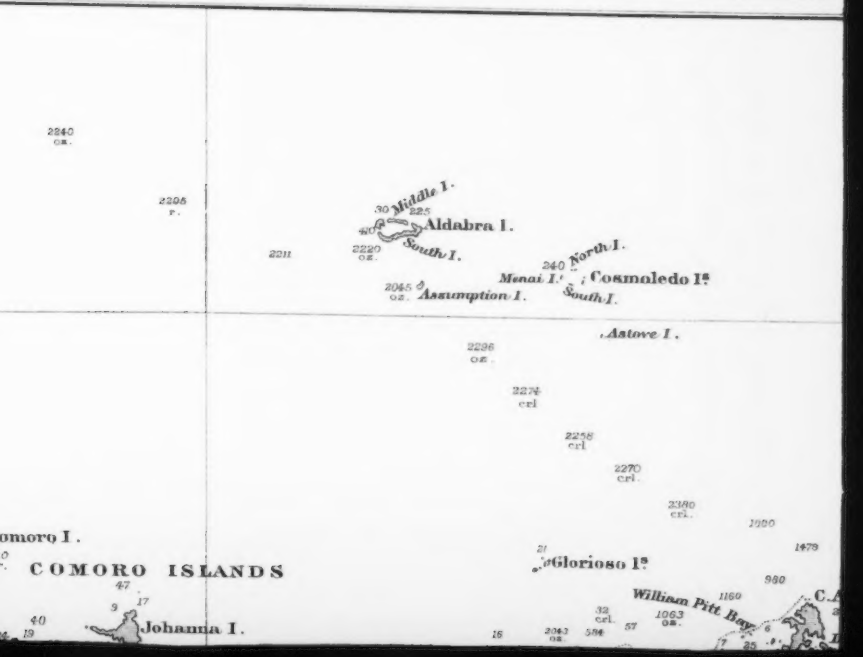
Pacific, South. **U.S. Weather Bureau.**

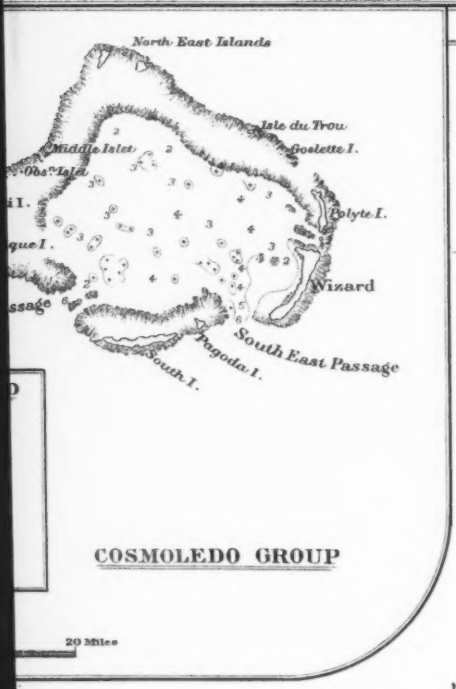
Meteorological chart of the South Pacific Ocean, Season—September, October, and November, 1910. Washington: Department of Agriculture, U.S. Weather Bureau, 1910. *Presented by the U.S. Weather Bureau.*

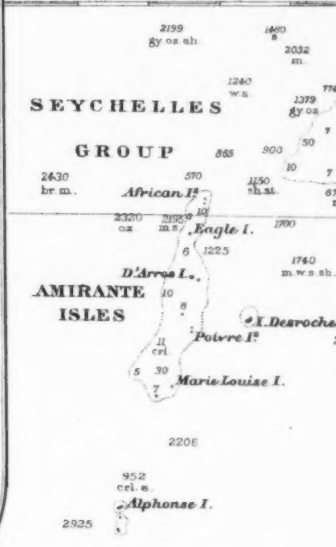
N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

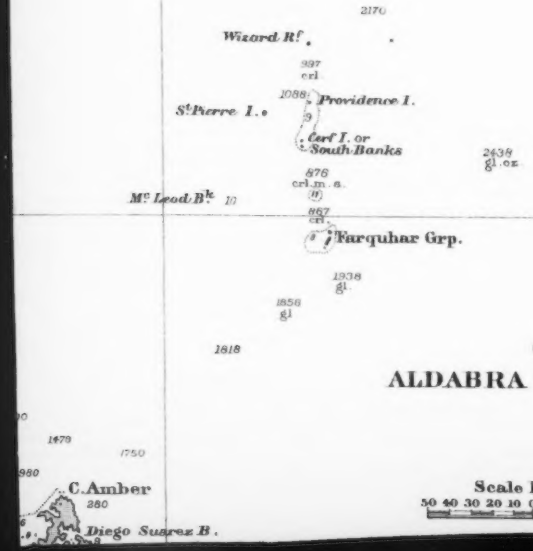

40°
5°
10°
Mombasa
Pemba Channel
PEMBA I.
ZANZIBAR I.
Mafia I.
Kilwa Kisiwani
Kiswere Harbour
Mchinga Bay
Mikindani Bay
Rovuma Bay
C. DELGARDO
Wamizi I.
KERIMBA
ISLANDS
Nameguo Pass
Mahatto I.
St. Lazarus
Moroni
Como
West Pt
West I.
Middle
Western Channels
Euphrates I.
Lagoon
Couroupa
Main
Tamarind Pt
Dunes
ALDABRA ISL
AFRICA


East Channel (Passe Houareau)
Coconut I. (Ile Michel)
Partly dry at Low Water
Hodoul Pt
Takamaka
Dunes Jean Louis
Dunes de Maistre
Johannes Pt
Mensi I.
Moustique I.
South West Passage
ASSUMPTION ISLAND
S.E. Point
ASTOVE ISLAND
Natural Scale 1: 250,000 or 1 Inch = 3·94 Statute Miles.


Middle I.
Aldabra I.
South I.
North I.
Menai I.
Cosmoledo Is
Assumption I.
South I.
Astove I.
COMORO ISLANDS
Johanna I.
Glorioso Is
William Pitt Bay







INDIAN OCEA

Chart to illustrate a p

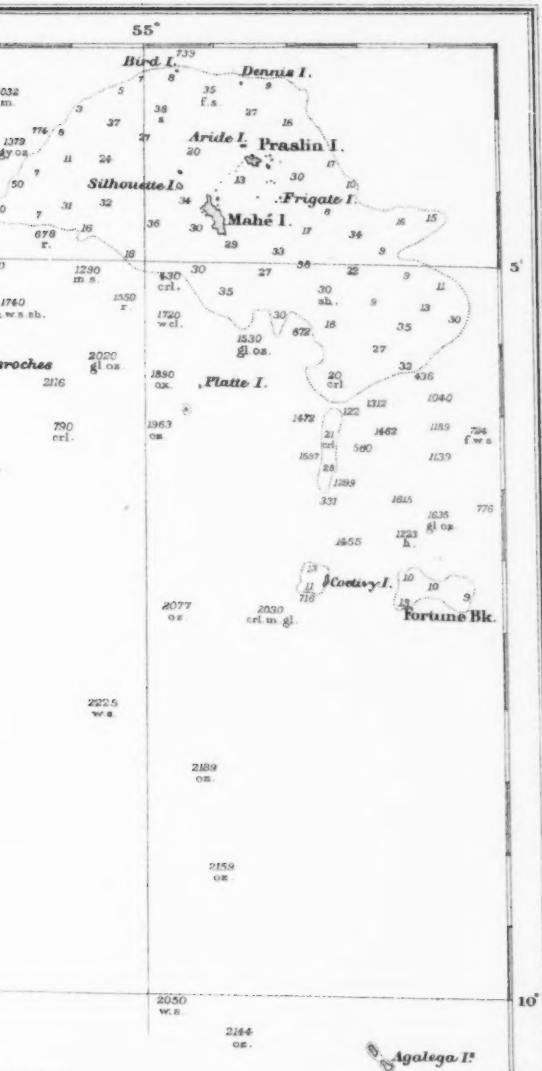
ALDABRA AND NEIGHBOU

by

J. C. F. FRYER

Scale 1 : 5,000,000 or 1 Inch = 78·

50 40 30 20 10 0 50 100



OCEAN

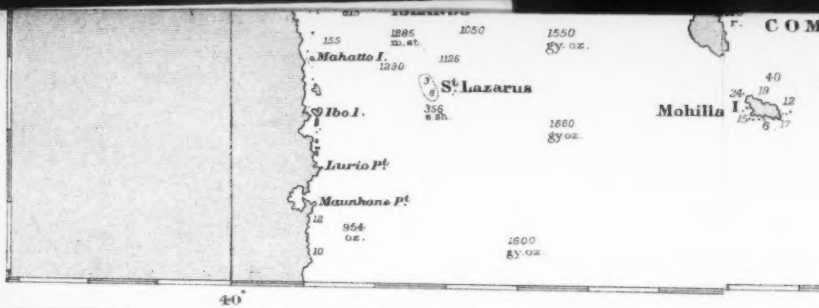
e a paper on

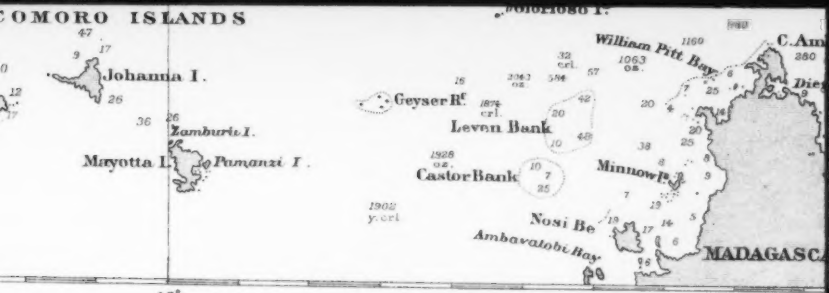
SOURING ISLANDS

YER.

= 78·9 Statute Miles.

100 150 200


155
1286
m. et.
1050
1550
gy. oz.
Mahatto I.
1230
1126
St. Lazarus
Ibo I.
356
s. sh.
1660
gy. oz.
Mohilla I.
40
24
19
12
15
6
17
Lurio Pt.
Mauruhane Pt.
12
954
oz.
10
1600
gy. oz.
40°



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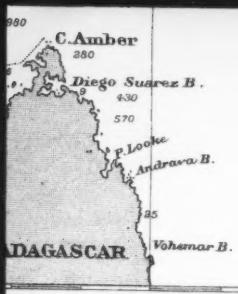


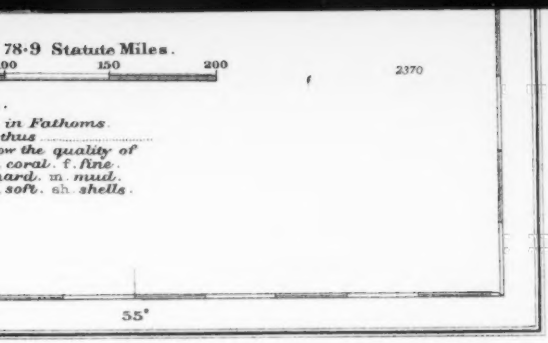
Scale 1 : 5,000,000 or 1 Inch = 78.9

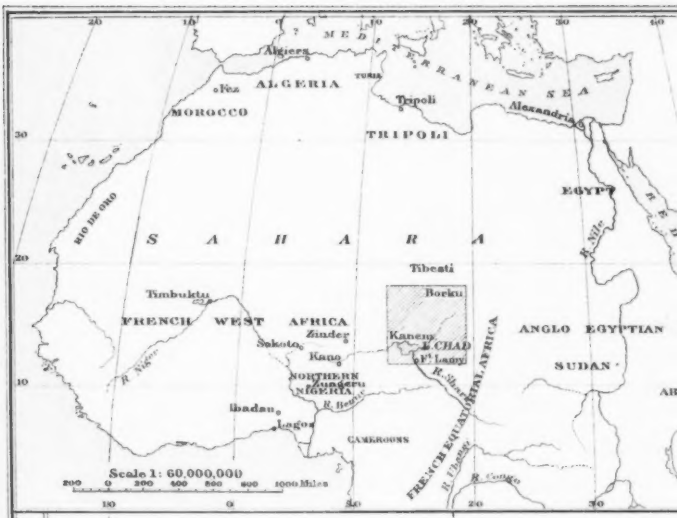
50 40 30 20 10 0 50 100

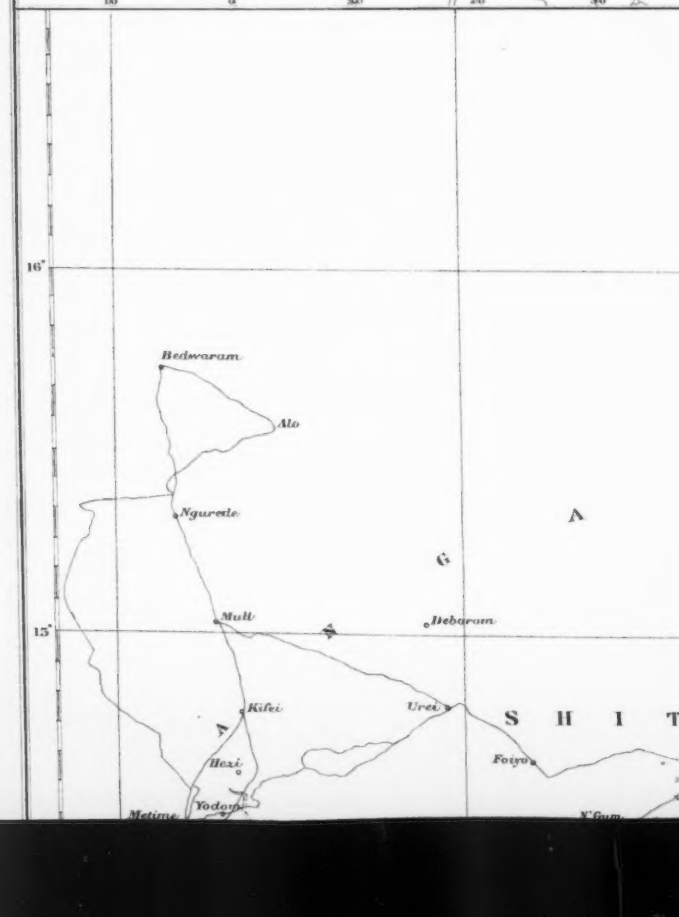
Reference.

The soundings are expressed in F
The 100 fathom line is shown thus
The following abbreviations show th
bottom :- br. *brown*. cl. *clay*. crl. *coral*
gl. *globigerina*. gy. *gray*. h. *hard*
oz. *ooze*. r. *rock*. s. *sand*. sft. *soft*
w. *white*.

ciety


78·9 Statute Miles.
00
150
200
2370
in Fathoms.
thus
w the quality of
coral. f. fine.
ard. m. mud.
soft. sh. shells.
55°


Algiers
ALGERIA
Fez
MOROCCO
TUNIS
Tripoli
TRIPOLI
Alexandria
EGYPT
RIO DE ORO
S A H A R A
R. Nile
Tibesti
Timbuktu
Bocku
FRENCH WEST AFRICA
Zinder
Sokoto
Kano
Kanem
L. CHAD
Ft Lamy
ANGLO EGYPTIAN
SUDAN
R. Niger
NORTHERN NIGERIA
Zungeru
R. Benue
Ibadan
Lagos
CAMEROONS
R. Shari
FRENCH EQUATORIAL AFRICA
R. Ubangi
R. Congo
Scale 1: 60,000,000
200 0 200 400 600 800 1000 Miles


16°
Bedwaram
Alo
Ngurcte
A
G
15°
Mull
Debaram
Kilei
Urei
S H I T
A
Hexi
Foyo
Yodom
Metime
N'Gum

18°

Wani 620

T O

S U L T U

M O

Hangara 741

Sekhab 755

O

B

E G E I

Hacha 745

SHIL

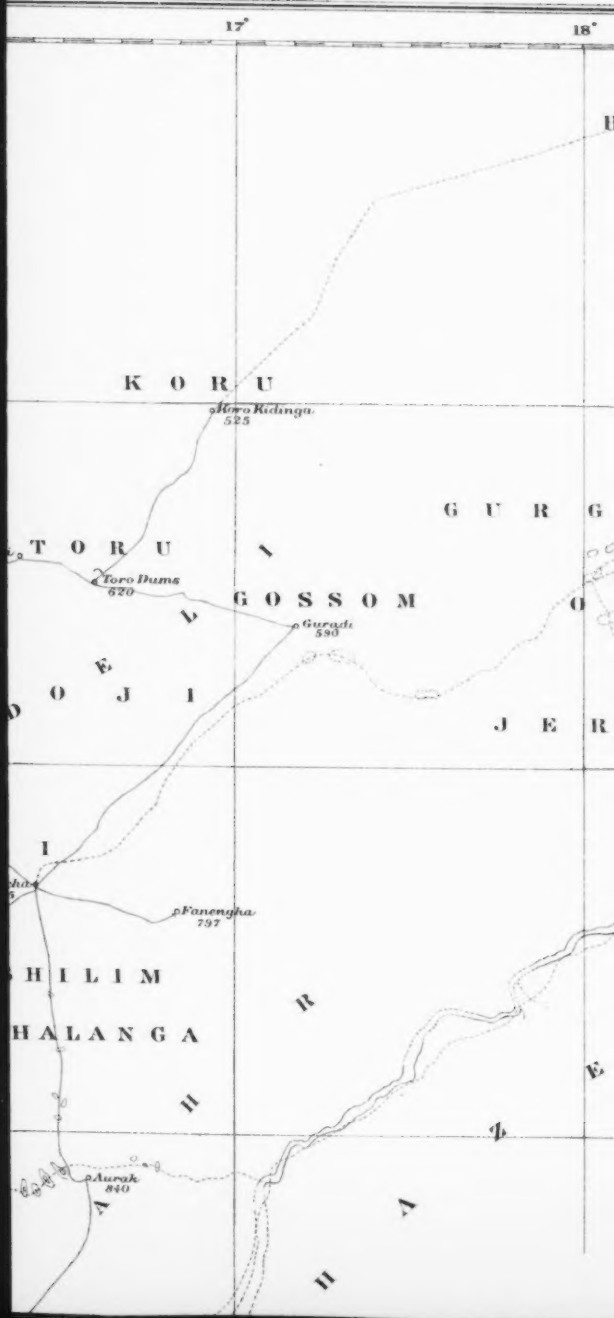
FAHALA

T A T I

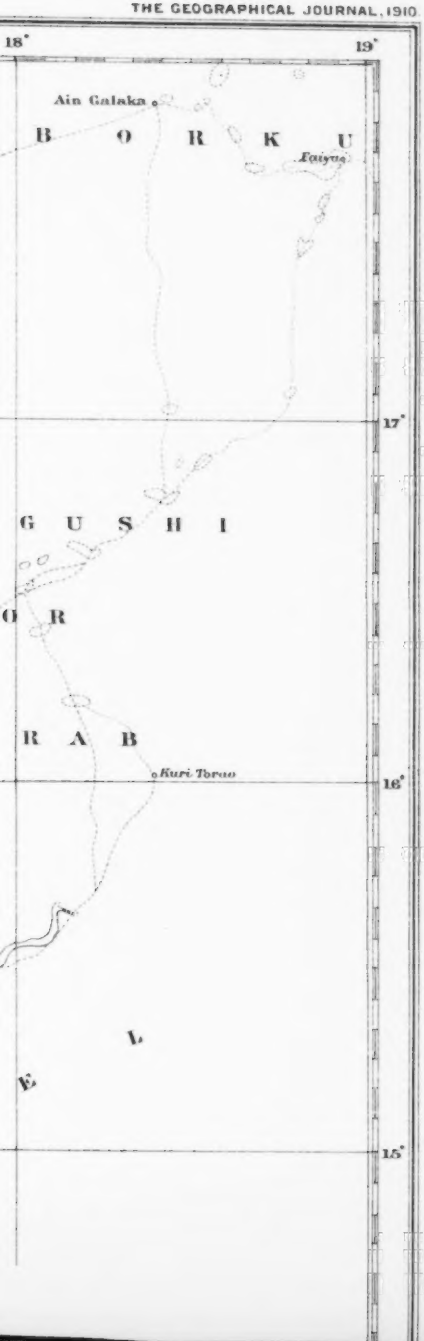
Zigei 1036

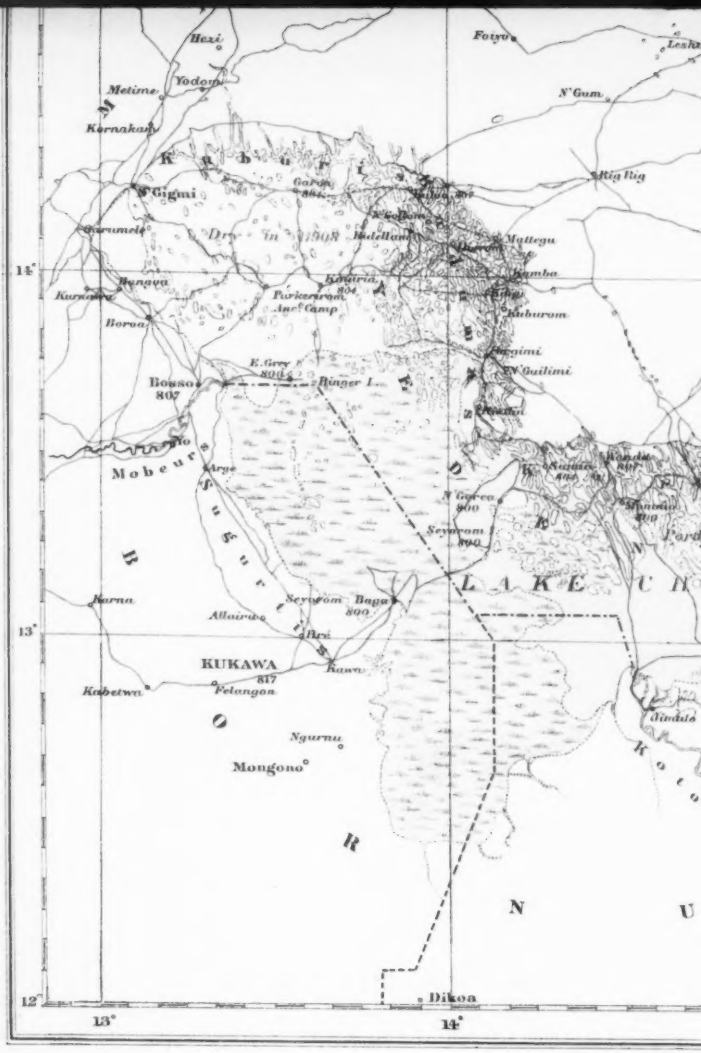
Leskan

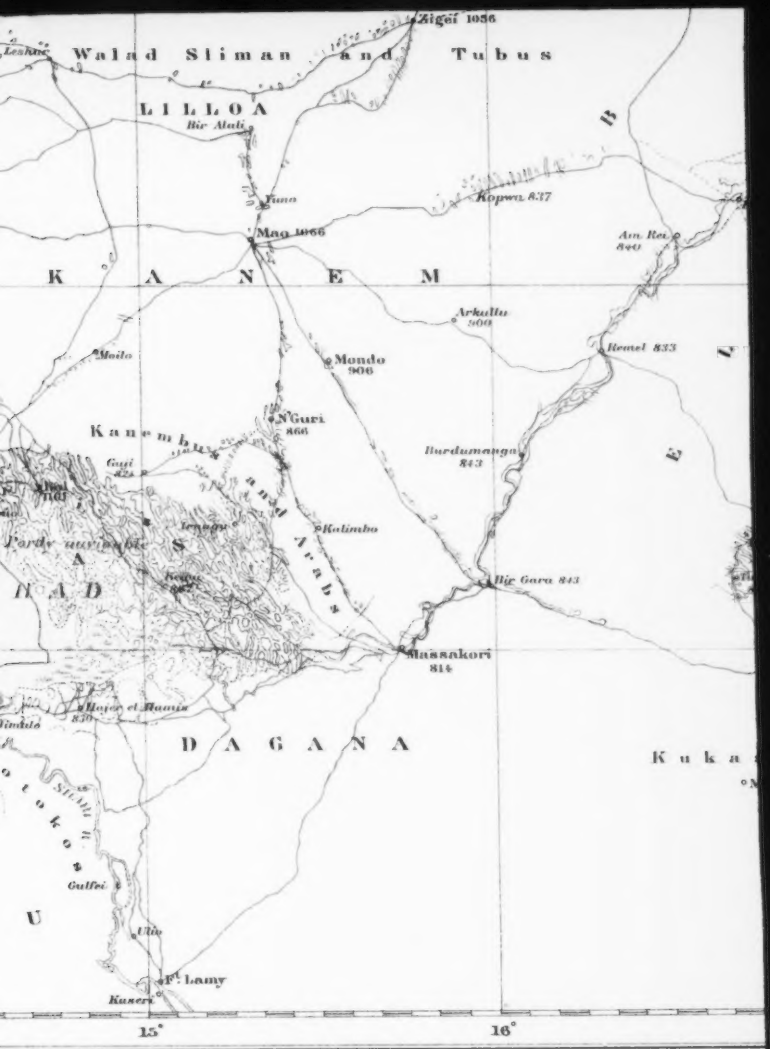
Walad Sliman and Tubus


17°
18°
KORU
Koro Kidinga
525
TORU
Toro Dums
620
GOSSOM
Gurudi
590
Fanengha
797
Aurak
840

LAKE CHAD
TILHO.




Hezi
Yodom
Metime
Kernakam
Gigmi
Garum
Garumele
Dry in 1908
Bedellam
Mattegu
Kambe
Kurumbe
Kaburom
Kaderia
Forkerorom
Ant. Camp
Borua
Bosso
807
E. Grey
800
Ringer I.
Moheurs
Arge
Seyerom
Baga
800
Kurna
Allairwa
Bri
KUKAWA
817
Kawa
Kabetwa
Felangon
Ngurnu
Mongono
Dikoa
Foyya
N'Gum
Rig Rig
Lesko
Mandia
807
Nguiro
Mamnia
Seyerom
800
N'Gorea
800
LAKE
13°
14°
12°



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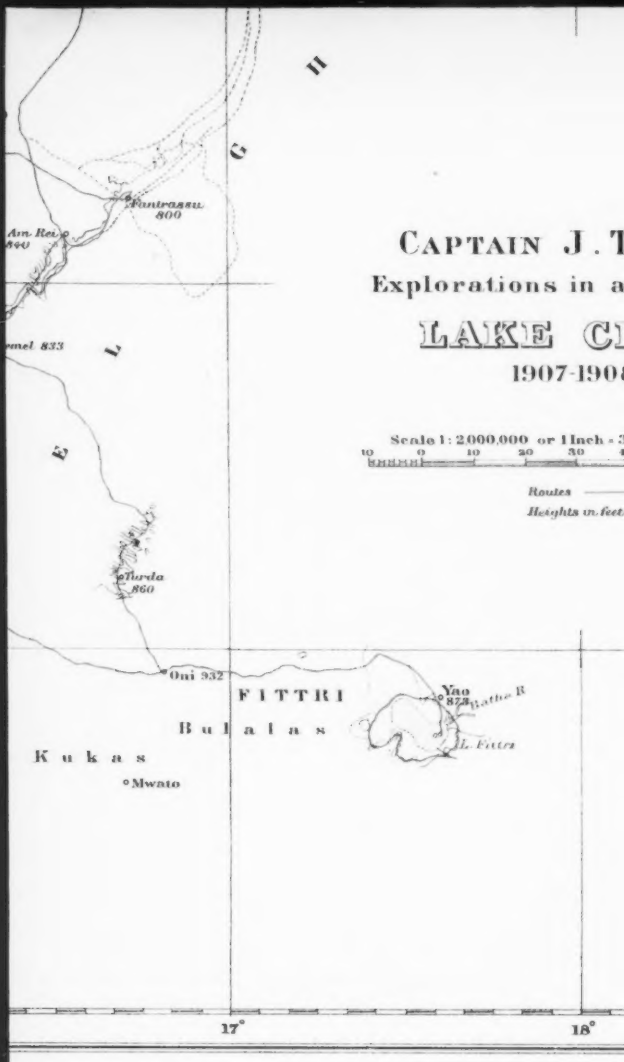

CAPTAIN J. T
Explorations in a
LAKE C
1907-190
Scale 1: 2,000,000 or 1 Inch =
Routes
Heights in feet
Pantrassu
800
Ain. Rei
840
mel 833
Nurda
860
Oni 932
FITTRI
Bulalas
Kukas
Mwato
Yao
872
Lake B
L. Fitt
17°
18°

J. TILHO'S

n and around

CHAD

1908.

nch = 31·6 Statute Miles.

0 40 50 60 70 Stat Miles

n feet.

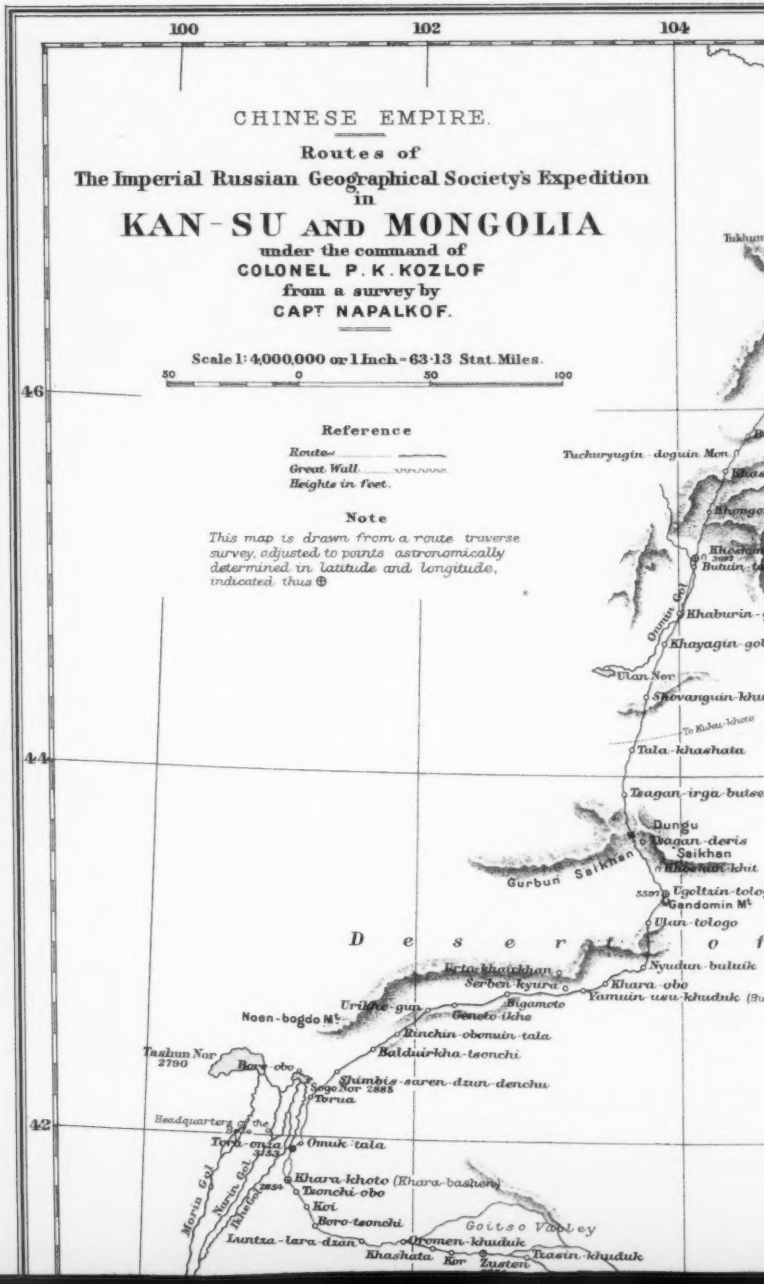
14°

13°

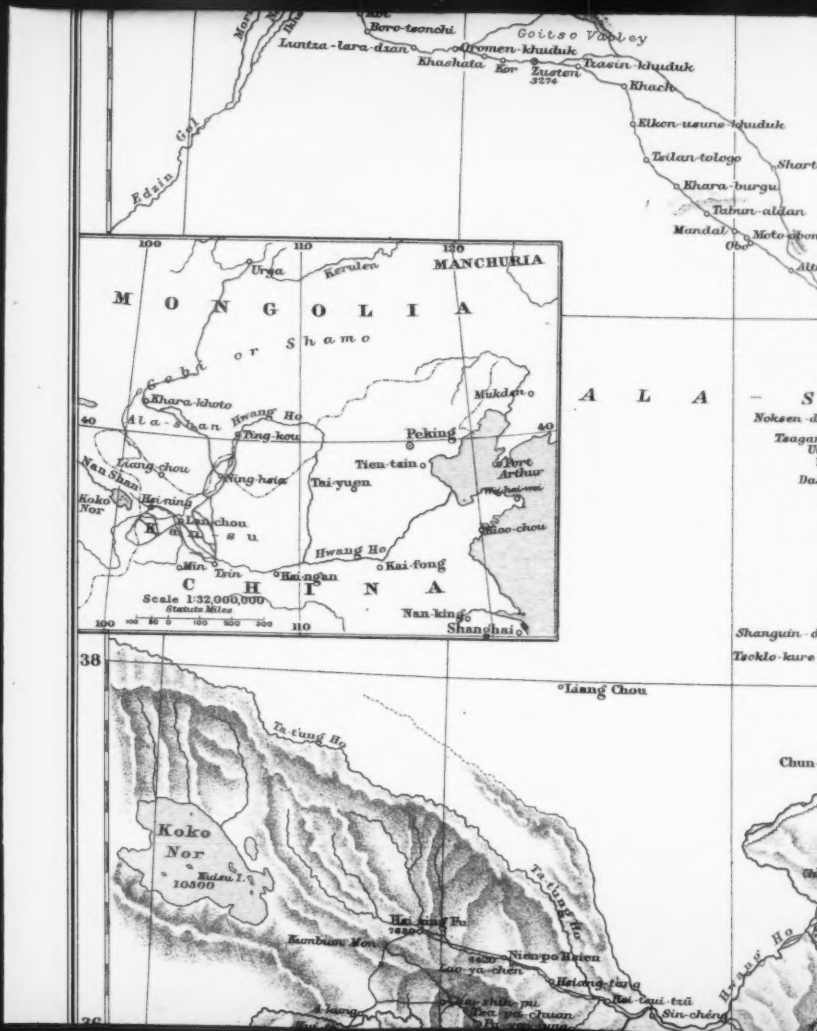
12°

8°

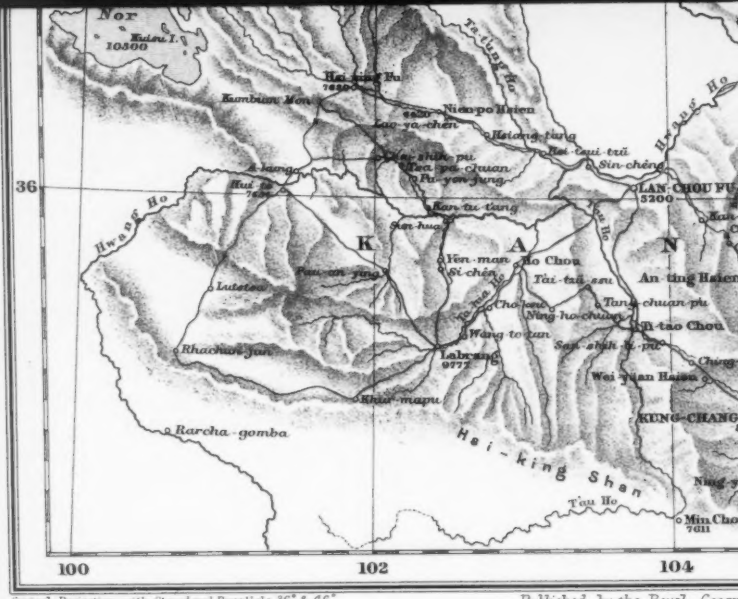
19°


100
102
104
CHINESE EMPIRE.
Routes of
The Imperial Russian Geographical Society's Expedition
in
KAN-SU AND MONGOLIA
under the command of
COLONEL P. K. KOZLOF
from a survey by
CAPT NAPALKOF.
Scale 1: 4,000,000 or 1 Inch = 63·13 Stat. Miles.
50 0 50 100
46
44
42
Reference
Routes
Great Wall
Heights in feet.
Note
This map is drawn from a route traverse survey, adjusted to points astronomically determined in latitude and longitude, indicated thus ⊕
Tsaidam
Tuchuryugin doguin Mon
Khaburin
Khayagin-gol
Ulan Nor
Shevanguin-khuduk
To Kuku-khoto
Tala-khashata
Tsagan-irga-butsa
Dungu
Dagan-deris
Saikhan
Khoshar-khit
Gurbun Saikhan
5507
Ugoltsin-tolo
Gandomin Mt.
Ulan-tologo
D e s e r t o f
Ecta-khaichhan
Nyudun-buluk
Serbar-kyura
Khara-obo
Yamuin-usu-khuduk
Bigamoto
Urikhe-gun
Noen-bogdo Mt.
Geneto-ikhe
Rinchin-obonuin-tala
Baldurikha-tsonchi
Tashun Nor
2790
Bara-obo
Shimbis-saren-dzun-denchu
Sogo Nor 2685
Torrua
Headquarters of the
Torn-onta
3153
Omuk-tala
Khara-khoto (Khara-bashen)
Tsonchi-obo
2954
Kui
Boro-tsonchi
Goitso Valley
Luntza-tara-dzan
Otromen-khuduk
Khashata
Ror
Zuuren
Tsasin-khuduk
Marsin Gol
Nom Gol
Tharlon

CHINESE EMPIRE.
Kozlof.


Boro-tsonchi
Goitso Valley
Tuntza-tara-dzan
Khashata
Kor
Tusten
3274
Trasin-khuduk
Khacho
Elkon-usune-khuduk
Tsilan-tologo
Khara-burgu
Tabun-aldan
Mandal
Edzin Gol
MANCHURIA
MONGOLIA
Urga
Kerulen
Gobi or Shamo
Khara-khoto
Ala-shan
Hwang Ho
Ting-kou
Peking
Mukden
Liang-chou
Nan Shan
Koko Nor
Hei-ning
Lan-chou
Kan-su
Ning-hsia
Tai-yuen
Tien-tsin
Port Arthur
Kiao-chou
Hwang Ho
Min
Trin
Kai-fong
Kai-ngan
CHINA
Nan-king
Shanghai
Scale 1:32,000,000
Statute Miles
Liang Chou
Ta-tung Ho
Koko Nor
Erein I.
10300
Hei-ning Fu
7850
Nien-po Erien
Ta-tung Ho
Hwang Ho
Sin-chéng

Ho
Hwang
Ting-kou
Tchetom-gol
Tzagan-tokho
Durbun-usu
Shabokhtu
Namburuiseh-khit Mon.
Shi-tsui-tzu
3890
Gumburten-khud
Jaran-bansin
Tin'khen-dugun Mon.
Maltach
Chun-cheng
Lin-kha pu
Yu-hu-tun
Ling Chou
3458
Chu-ching-pu
Ting-tsi-pu
Chaompu
Ping-yüan Hsien
Pan-tan
Yanchiau
Pangu-chuin 4020
Tao-tunta
Changouudin
Liwanpu
Chi-in
Hei-ching-chi
5230
Sun-ying
Tsing-yuan Hsien
4172
Hai-ching Hsien
Kuo-ching
Chun-wei Hsien
4610
Ning-hua-pu
2400
Shanchiowen
Chiumachin
Tzau-yuan-pu
Tsaidam
Altuin-buluik
Durbuns-shoto
Tzakeldekto-khuduk
Tzagan-buluik
3647
Khoshun-usu
Cholon-engoltsy
Uurgin-khuduk
Tzagan-suburgan
Uzur-khuduk
Khoto-chuin Gol
Dashpu-khuduk
Sholyuba
Khalu-khuduk
Tauk
Ting-yüan-ying
4622
Baruk-Khit
Uzun-ikhine-chol
Tsatse-tologo
Bain-buluik
Tenko
Sin-ku-tzu
Sin-fung-pu
Chin-chi-tang
Ta-la-chi
Kuo-ching
Ordos
Shan
Ho
Hwang
Ho
40
38
36



Conical Projection with Standard Parallels 36° & 46°

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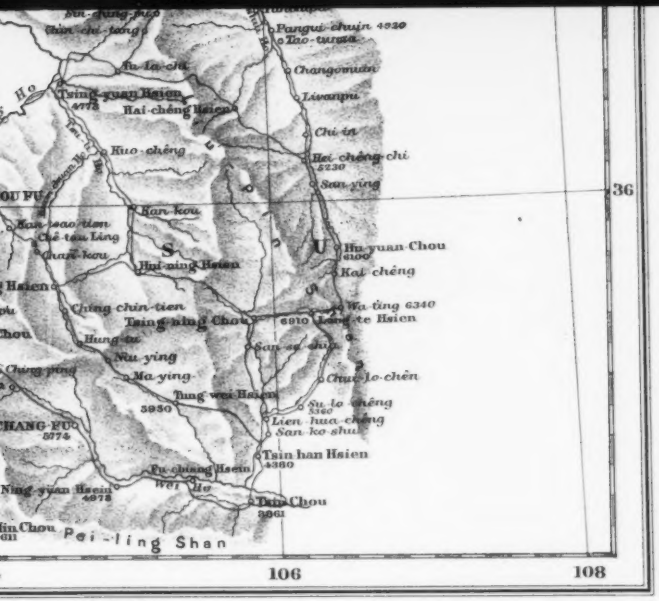


Geographical Society

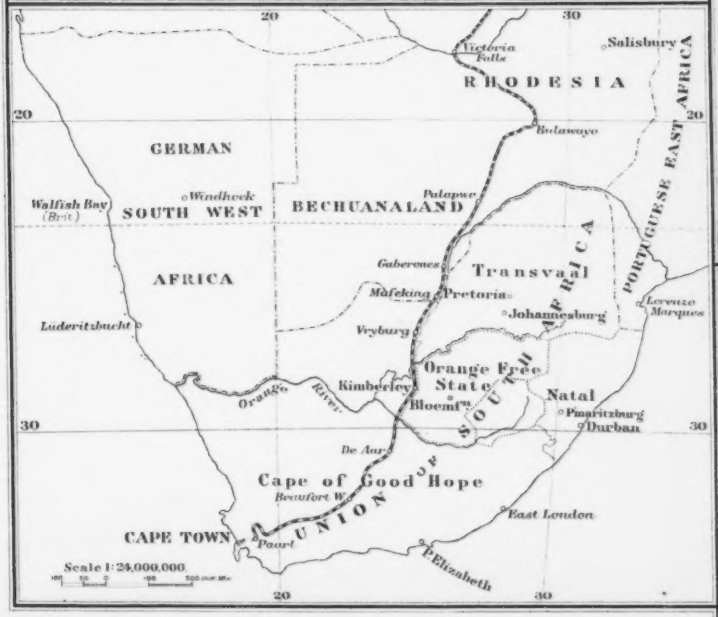
SOUTH AFRICA.

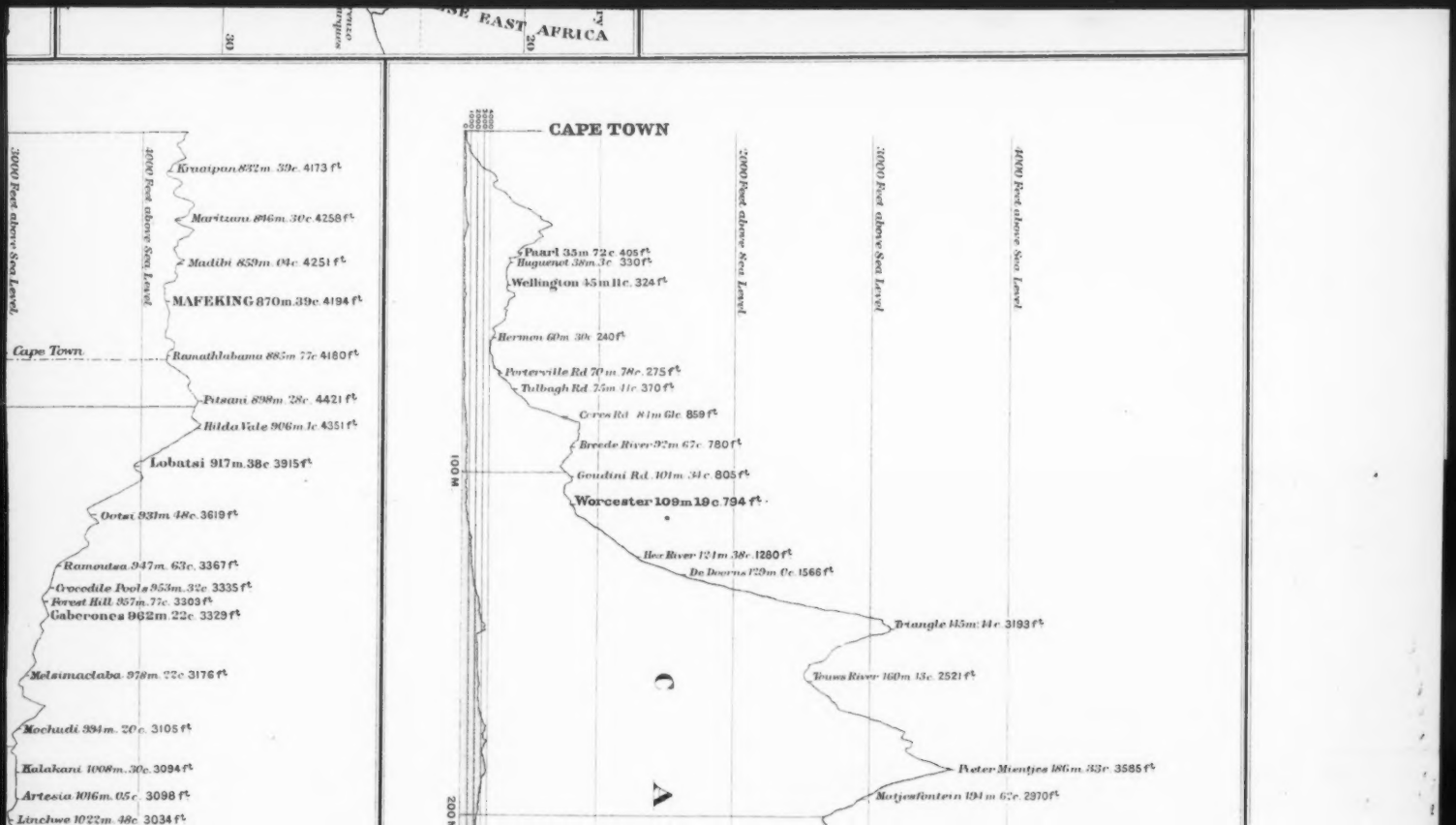
Section along the railway
from
CAPE TOWN TO VICTORIA FALLS
compiled from levels
taken from the railway surveys
by
A. H. WALLIS.
(Act. Resident Engineer Cape Gov. Rys.)
1910.

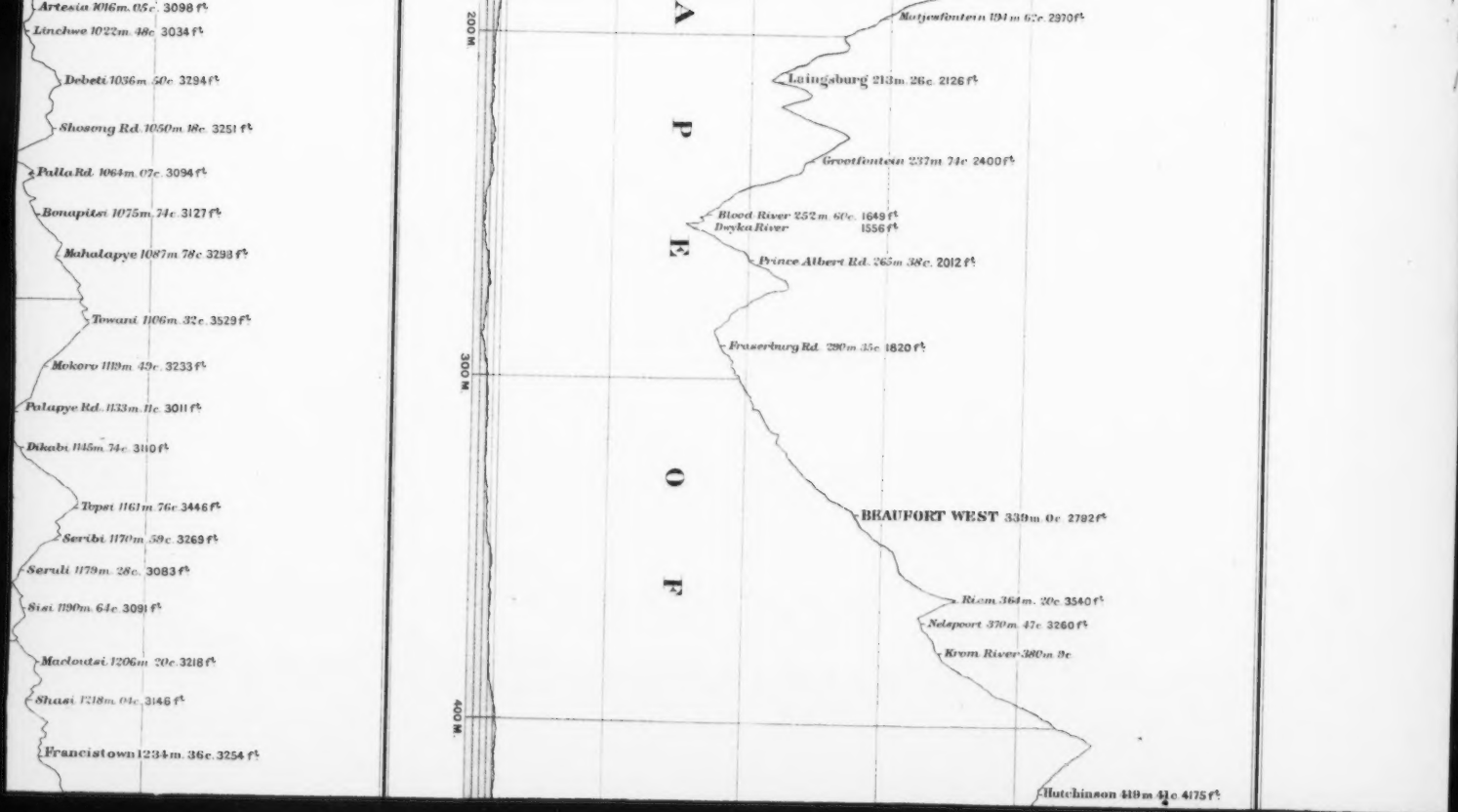
Scale 1:3,000,000 or 1 Inch = 47·35 Stat. Miles.

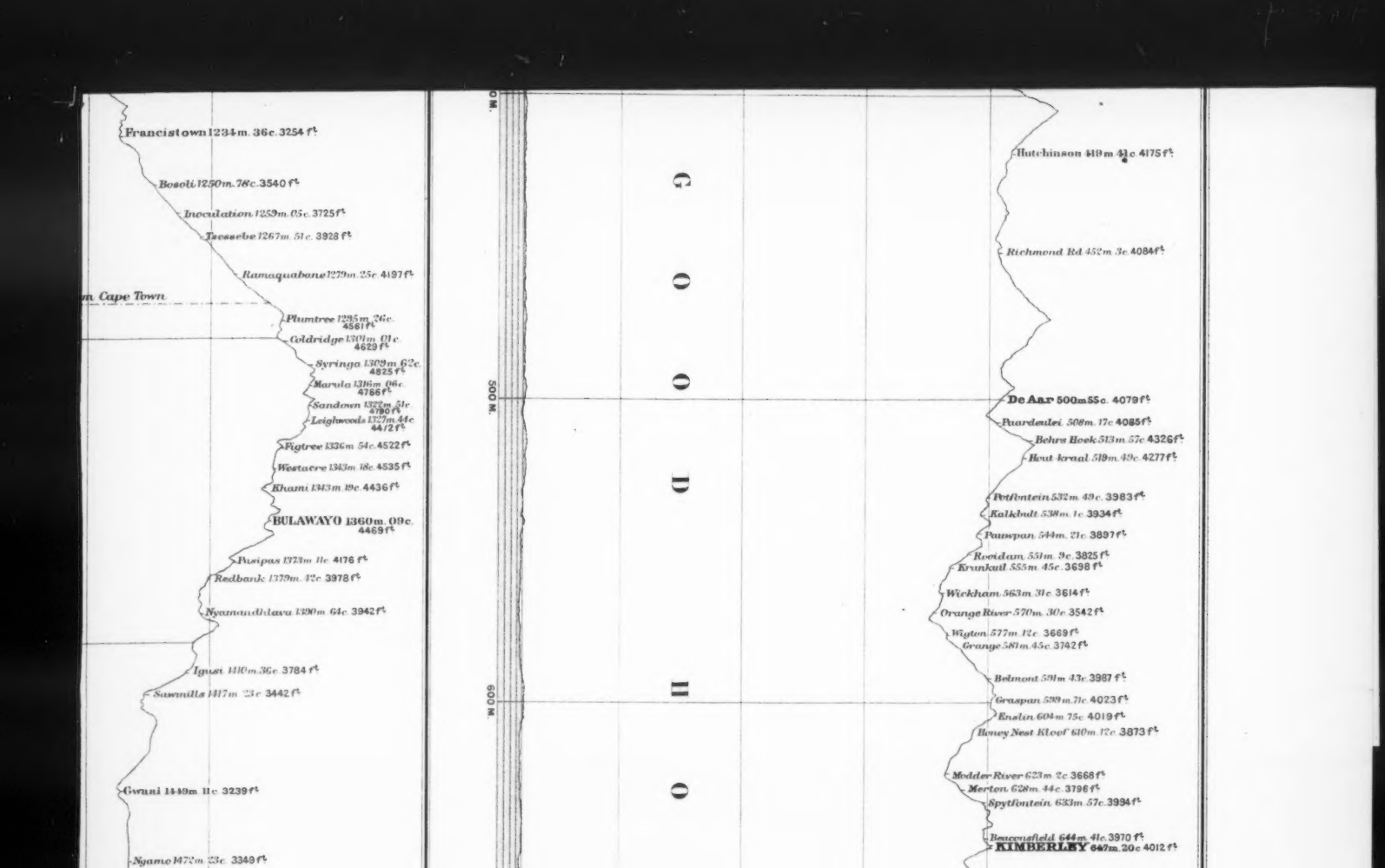
10 5 0 20 40 60 80

Vertical Scale exaggerated 200 times
The shaded part shows the section exaggerated 10 times



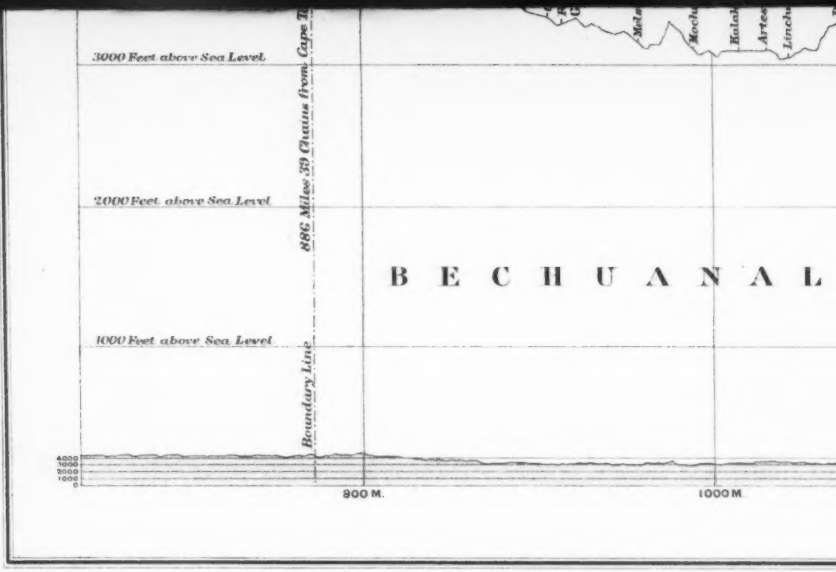

EAST AFRICA
30
20
3000 Feet above Sea Level
4000 Feet above Sea Level
Kwaipan 832m. 39c. 4173 ft
Maritzani 846m. 30c. 4258 ft
Madibi 859m. 04c. 4251 ft
MAFEKING 870m. 39c. 4194 ft
Cape Town
Ramathlabama 885m. 77c. 4180 ft
Pitsani 898m. 28c. 4421 ft
Hilda Vale 906m. 1c. 4351 ft
Lobatsi 917m. 38c. 3915 ft
Ootsi 931m. 48c. 3619 ft
Ramoutsa 947m. 63c. 3367 ft
Crocodile Pools 853m. 32c. 3335 ft
Forest Hill 857m. 77c. 3303 ft
Gaberones 862m. 22c. 3329 ft
Molsimaclaba 878m. 22c. 3176 ft
Mochudi 894m. 20c. 3105 ft
Kalakani 1008m. 30c. 3094 ft
Artesia 1016m. 05c. 3098 ft
Linchwe 1022m. 48c. 3034 ft
CAPE TOWN
1000 Feet above Sea Level
2000 Feet above Sea Level
3000 Feet above Sea Level
4000 Feet above Sea Level
Paarl 35m. 72c. 405 ft
Huguenot 38m. 3c. 330 ft
Wellington 45m. 11c. 324 ft
Hermon 60m. 30c. 240 ft
Porterville Rd. 70m. 78c. 275 ft
Tulbagh Rd. 75m. 41c. 370 ft
Ceres Rd. 81m. 61c. 859 ft
Breede River 92m. 67c. 780 ft
Goudini Rd. 101m. 34c. 805 ft
Worcester 109m. 19c. 794 ft
Hex River 124m. 38c. 1280 ft
De Doorns 129m. 0c. 1566 ft
Triangle 135m. 14c. 3193 ft
Touws River 160m. 13c. 2521 ft
Peter Muntjes 186m. 33c. 3585 ft
Matjesfontein 194m. 62c. 2970 ft

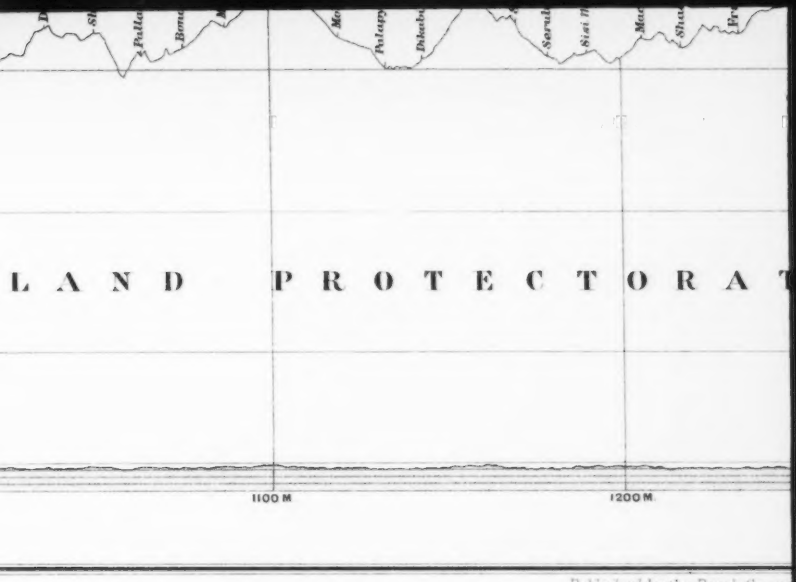

Artesia 1016m. 05c. 3098 ft
Linchwe 1022m. 48c. 3034 ft
Debeti 1036m. 50c. 3294 ft
Shosong Rd. 1050m. 18c. 3251 ft
Palla Rd. 1064m. 07c. 3094 ft
Bonapitse 1075m. 74c. 3127 ft
Mahalapye 1087m. 78c. 3298 ft
Toward. 1106m. 32c. 3529 ft
Mokoro 1119m. 45c. 3233 ft
Palapye Rd. 1133m. 11c. 3011 ft
Dikabi 1145m. 74c. 3110 ft
Topsi 1161m. 76c. 3446 ft
Seribi 1170m. 59c. 3269 ft
Seruli 1179m. 28c. 3083 ft
Sisi 1190m. 64c. 3091 ft
Macloutsi 1206m. 20c. 3218 ft
Shasi 1218m. 04c. 3146 ft
Francistown 1234m. 36c. 3254 ft
200 M
300 M
400 M
Matjesfontein 194m 62c. 2970 ft
Laingsburg 213m. 26c. 2126 ft
Grootfontein 237m. 74c. 2400 ft
Blood River 252m. 60c. 1649 ft
Dwyka River 1556 ft
Prince Albert Rd. 265m. 38c. 2012 ft
Fraserburg Rd. 290m. 35c. 1820 ft
BEAUFORT WEST 339m. 0c. 2792 ft
Rio m. 364m. 20c. 3540 ft
Nelspoort 370m. 47c. 3260 ft
Krom River 380m. 9c
Hutchinson 419m. 41c. 4175 ft


Francistown 1234m. 36c. 3254 ft
Bosoli 1250m. 78c. 3540 ft
Inoculation 1259m. 05c. 3725 ft
Tessebe 1267m. 51c. 3928 ft
Ramaquabane 1279m. 25c. 4197 ft
m. Cape Town.
Plumtree 1395m. 26c. 4561 ft
Goldridge 1391m. 01c. 4629 ft
Syringa 1309m. 62c. 4825 ft
Marula 1316m. 06c. 4766 ft
Sandown 1325m. 31c. 4790 ft
Leighwoods 1327m. 44c. 44/2 ft
Figtree 1336m. 54c. 4522 ft
Westacre 1343m. 18c. 4535 ft
Khami 1343m. 19c. 4436 ft
BULAWAYO 1360m. 09c. 4469 ft
Paripas 1373m. 11c. 4176 ft
Redbank 1379m. 42c. 3978 ft
Nyamandhlava 1390m. 64c. 3942 ft
Iguai 1410m. 36c. 3784 ft
Sawmills 1417m. 23c. 3442 ft
Gwuni 1449m. 11c. 3239 ft
Nyamo 1472m. 23c. 3349 ft
500 M.
600 M.
GOOD HOPE
Hutchinson 619m. 41c. 4175 ft
Richmond Rd. 452m. 3c. 4084 ft
De Aar 500m. 55c. 4079 ft
Paardeulei. 508m. 17c. 4085 ft
Behrs Hoek. 513m. 57c. 4326 ft
Hout kraal. 518m. 49c. 4277 ft
Potfontein 532m. 49c. 3983 ft
Kalkbult. 538m. 1c. 3934 ft
Pampan. 544m. 21c. 3897 ft
Roodam. 551m. 9c. 3825 ft
Krunkuil. 555m. 45c. 3698 ft
Wickham. 563m. 31c. 3614 ft
Orange River. 570m. 30c. 3542 ft
Wigton. 577m. 12c. 3669 ft
Grange. 581m. 45c. 3742 ft
Belmont. 591m. 43c. 3987 ft
Graspan. 599m. 71c. 4023 ft
Enslin. 604m. 75c. 4019 ft
Honey Nest Kloof. 610m. 12c. 3873 ft
Modder River. 623m. 2c. 3668 ft
Merton. 628m. 44c. 3796 ft
Spytfontein. 633m. 57c. 3994 ft
Beaconsfield. 644m. 41c. 3970 ft
KIMBERLEY. 647m. 20c. 4012 ft

SOUTH AFRICA.
Wallis.

Beaconsfield 644m. 40c. 3970 ft.
KIMBERLEY 640m. 20c. 4012 ft.
Riverton Rd. 683m. 62c. 3747 ft.
Windsorton Rd. 634 m. 43c. 3836 ft.
Warrenton 608m. 39c. 3931 ft.
34 streams 604m. 66c. 3881 ft.
Pniel 716m. 53c. 3648 ft.
Bamga 733m. 3c. 3589 ft.
VRYBURG 774 m. 12c. 3890 ft.
Paradise 781m. 06c. 4002 ft.
Devondale 780m. 31c. 4129 ft.
Saltpan 797m. 31c. 4270 ft.
Doornbult 806m. 0c. 4470 ft.
Wiesing 813m. 3c. 4511 ft.
Marhope 820m. 72c. 4320 ft.
4000 Feet
3000 Feet
2000 Feet
1000 Feet
P E
700 M.
800 M.
Ngamo 1472m. 23c. 3349 ft.
Intandhla 1485m. 10c. 3376 ft.
Matsuda 1507m. 42c. 3577 ft.
Dula 1520m. 3c. 3589 ft.
Inyantue 1536m. 65c. 3094 ft.
1555m. 63c. 2619 ft.
1571m. 72c. 2447 ft.
Katuna 1590m. 11c. 2987 ft.
4000 Feet
3000 Feet
Kosi 1626m. 05c. 3489 ft.
VICTORIA FALLS 1639m. 75c. 2994 ft.


3000 Feet above Sea Level
2000 Feet above Sea Level
1000 Feet above Sea Level
886 Miles 39 Chains from Cape T
Boundary Line
BECHUANAL
4000
3000
2000
1000
0
900 M.
1000 M.



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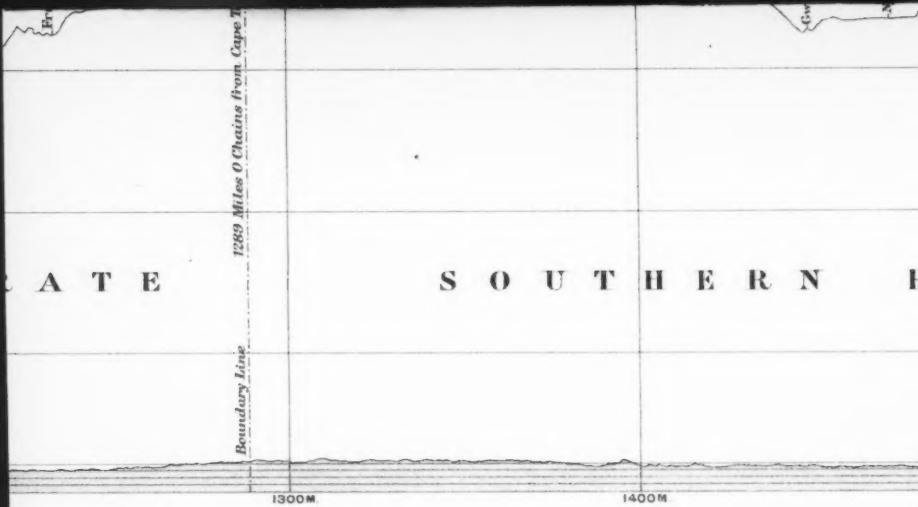

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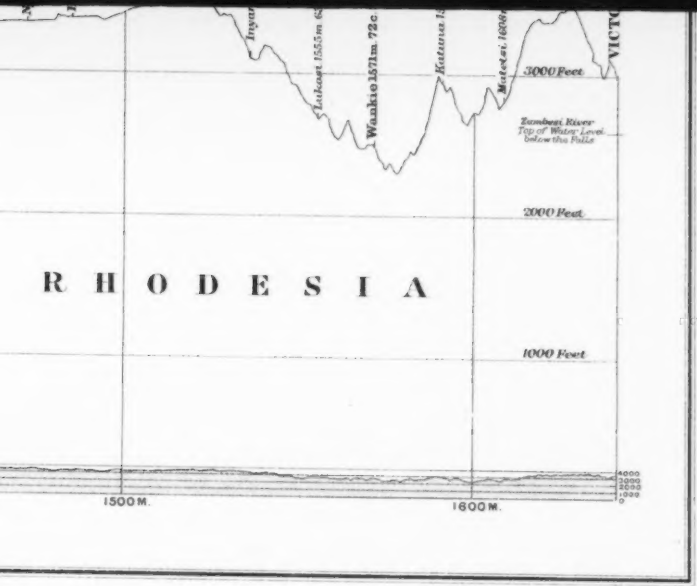
Inyanga
Inyangani 8517 ft.
Inyangani 8517 ft.
Inyangani 8517 ft.